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SCENIC AND RECREATIONAL PERCEPTIONS OF FOREST BURN AREAS AND THE EFFECTS OF FIRE INFORMATION ON PUBLIC KNOWLEDGE AND ATTITUDE

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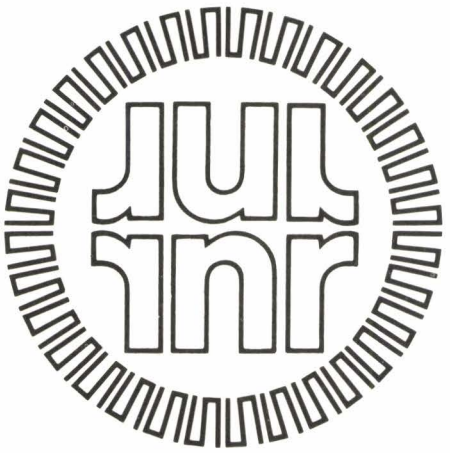

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SCENIC AND RECREATIONAL PERCEPTIONS OF FOREST BURN AREAS AND THE EFFECTS OF FIRE INFORMATION ON PUBLIC KNOWLEDGE AND ATTITUDE

by

Jonathan G. Taylor

and

Terry C. Daniel

Final Report

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School of Renewable Natural Resources

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MANAGEMENT SUMMARY

The present study was designed to test public perceptions of both scenic quality and recreational acceptability of southwestern ponderosa pine forests exhibiting one-to-five years of recovery from both light (prescribed) and severe fire. Public information documents, using both production functions and line drawings to portray fire effects, were constructed and tested for effectiveness of communication.

The clearest distinction drawn, for both scenic quality and recreational acceptability, is between light-fire and severe-fire effects. Light fire improves scenic quality for a 3-to-4 year period, while severe fire seriously detracts from scenic quality for an unknown length of time exceeding the 5-year period tested. Recreational acceptability is differentiated according to the recreational activity selected: camping is nearly twice as sensitive to severe fire effects as scenic quality, and is somewhat disrupted by light fire effects; picnicking is second-most impacted by severe fire effects; hiking or backpacking is affected by severe fire to about the same degree as scenic quality; nature study is least affected. Picnicking, hiking and nature-study are not significantly affected by light fire. Thus a fire-effects sensitivity scale can be constructed ranging from nature-study, the least affected outdoor recreation; through hiking or backpacking; picnicking; to camping, the

most affected recreation activity. Fire management in forest recreation areas clearly must account for the type(s) of outdoor recreation intended. For example, camping is sensitive even to the relatively minor effects of light fire.

Provision of fire-effects information does not significantly affect scenic or recreational evaluation of forest burn areas. A slight shift in scenic evaluation may result from the information treatments, with graphic (line-drawing) depiction of effects exhibiting the greatest evaluation shift and quantitative production-function graphs having the least. These differences, however, are not statistically significant.

The fire-effects information brochures produced general "halo" effects on both fire knowledge and fire attitude as tested in a short-form questionnaire. In both instances, shifts are away from the uninformed position toward the expert position, the latter represented by questionnaire responses by a graduate, fire ecology seminar. Fire knowledge is most affected concerning usual fire intensity and size, ecosystem effects of light fires, and the impacts of fire on wildlife. Uninformed respondents generally agree with the experts concerning the effects of fire on soil erosion, on reducing future fire potential, and on air pollution. Knowledge of the causes of fire, water pollution effects and vegetative recovery time remain relatively unchanged. No consistent differences in fire knowledge are attributable to the different forms of presentation, i.e., production functions vs. line drawings vs. the two combined.

Results of the experiment indicate that the general public can be moved toward greater tolerance for fires in ponderosa forests through

provision of fire-effects information. Informed subjects consistently tend away from the uninformed, less tolerant position toward the more tolerant, expert position. Here, some difference in attitude by type of information treatment is evident. Although production-function and line-drawing results are virtually indistinguishable, the full information treatment results (production functions plus line drawings) fairly consistently fall between those of the uninformed and the other two information treatments. This suggests that the combined information may constitute too much, or an information overload tending toward either confusion or rejection of the information presented. The fact that the full-information brochure received the lowest evaluative rating, and had the lowest proportion of respondents indicating they would read it if "received, unsolicited in the mail," would seem to support the suggestion that this brochure constitutes too much information.

A correlation analysis of the fire-knowledge responses with the fire-attitude responses shows that a relationship exists between attitude and knowledge concerning fires in the forest; greater knowledge correlates with greater tolerance of fire in the forest. These results substantiate the correlation reported by Stankey (1976) between knowledge and tolerance for fire among wilderness users.

Prescribed burning is found to be more generally accepted than forest managers might expect. Respondents in this survey -- whether informed of fire effects or not -- selected "forest managers should periodically burn underbrush and debris in pine forests" over 90 percent of the time. Both the expert and the line-drawing groups selected this

response unanimously. These findings support those reported by Rauw (1980) that the public is reasonably well informed about, and tolerant of, prescribed burning. A recent telephone survey of Tucson residents (see Cortner et al., 1979) also indicates a high level of public acceptance of prescribed fire.

The experiment, reported herein, was designed to explore relationships among several factors: perception of scenic quality and recreational acceptability; types of information presentation; and knowledge of and attitude toward fire in southwestern ponderosa pine forests. Through such an intractive design, it has been shown: that scenic perception is not equivalent to recreational acceptability perception; that provison of fire-effects information affects both fire knowledge and attitude but has little effect on perceptual evaluations; and that a correlation exists between fire knowledge and tolerance of fire. The general scenic and recreation evaluation response patterns are indicated by these results, but are based on only four slides per fire condition due to the nature of the interaction experiment. To produce statistically reliable production functions of scenic quality and recreational acceptability by recreation type, further experiments are needed which test single factors with more iterations (slides) per fire-recovery condition. In the present experiment, results are reported only for those recreation activities that had a sufficient number of respondents selecting them to give reasonably reliable results. The single factor, recreational acceptability experiments suggested should endeavor to capture other forms of outdoor recreation such as hunting, nature photography, ORV use, etc.

One further consideration is that just as ecosystem responses to fire vary from one forest type to another, human perceptual responses to scenic quality and recreational acceptability should also be expected to vary. Application of the experimental techniques employed in this experiment to other forest types should yield data valuable to forest managers in other forest regions. The present results indicate perceptual patterns and interrelationships. The further experiments suggested should generate quantitative data that would make response to legal mandates to manage forests for scenic quality and recreation easier and more reliable.

Of more subtle, but perhaps more profound consequence, would be further studies of the use of public information and education materials. The brochures developed for this project positively affect both fire knowledge and fire tolerance for ponderosa pine forests. Different forms of presentation, such as slide shows showing examples of the impacts discussed, should be investigated for effectiveness of communication; as well as more prolonged exposure to the existing information materials. Whether scenic or recreational evaluative responses could be modified through more intensive or prolonged information exposures is a question of theoretical importance which has profound implications for the forest manager. In an age of shifting management policies, reflecting changes in scientific understanding of ecosystem dynamics, just how "sold" do we want the general public to be on a specific management policy? Smokey Bear should not be replaced with a new image without very careful forethought and planning.

CHAPTER I

INTRODUCTION

The nature and structure of virgin southwestern ponderosa pine forests have frequently been described, both artistically and in scientific detail. Biswell et al. (1973) described the original Arizona ponderosa forest types as:

> ... more of a savanna or parkland than a forest ... a formation with widely-spaced trees with grassland understory or a formation consisting of groves of trees intermixed with pockets of grassland. All size classes were represented ... arranged in distinct groups rather than in admixtures ... Age groups were usually distinct and discontinuous ... a pattern of groups or clusters of even-aged and even-sized trees, saplings or seedlings existed often less than one acre in size. Each class was exclusive; a healthy stand seldom contained older trees with younger tree reproduction growing under them.
>
> New trees generally started in openings ... on bare mineral soil such as those created by surface fires ... usually large enough to provide the sunlight conditions conducive to rapid tree growth, but small enough to provide shading to the seedlings from the surrounding trees (p. 4).

The role that periodic fire has played in creating this forest structure has been discussed by numerous authors. Komarek (1969) has described southwestern ponderosa pine as "the forest that fire made." His studies of lightning-fire bioclimatic regions of the United States clearly demonstrate the long-term role lightning-caused fires have played in the development and structuring of southwestern ponderosa pine forests, particularly those in Arizona and New Mexico. Weaver (1951) found, through fire scar studies and dendrochronology, that natural fires

have occurred in ponderosa pine forests throughout the southwest on a six- to seven-year frequency. Dieterich (1980) reports evidence that some southwestern ponderosa forests may have fire intervals as short as 2.4 years.

These rates of fire recurrence were sufficient to prevent significant fuel build-up, and thus fires were generally of light to moderate intensity. These naturally occurring fires acted to remove competitive vegetation such as aspen, fir, incense cedar and emery oak, which tend to be less fire resistant but more shade tolerant than ponderosa pine. Moderate intensity fires could effectively thin pole stands, and occasional hot spots around dead snags would create clearings suitable for ponderosa regeneration. "The clumped pattern of ponderosa pine is the result of a cyclical pattern of community development governed by fire and by the (shade) intolerant nature of the species," (Cooper, 1960). Perhaps most succinctly stated by Jepson (1923), "Indeed the main silvical features, that is, density, reproductive power and dominance of types, are in great part expressions of the periodic fire status."

A policy of fire suppression by resource management agencies became dominant in the late 1800s and early 1900s (Kilgore, 1976). This, in combination with effects of early overgrazing of stock, has been particularly important in the establishment of dense reproduction stands characteristic of present-day ponderosa pine forests. These overcrowded stands show evidence of growth stagnation and, with fire exclusion, more tolerant associated climax species are becoming dominant in extensive areas (Weaver, 1955). Further, with the increasing fuel loading

resulting from rigorous fire suppression, danger of extensive and severe wildfire damage has greatly increased. Large masses of fuels have accumulated in the forests, including logs, limbs, bark, leaves, and slash. In addition, dense sapling stands (up to 30,000 stems per acre) are very often crowded under larger trees increasing crown fire potential. These fuels are all highly flammable (Biswell, et al., 1973).

Therefore, numerous researchers (Weaver, Komarek, Biswell, Kallander, Gaines, Cooper, and others) have been pointing out the need for reintroduction of fire into southwestern ponderosa pine forests as a management tool. Prescribed fire has been shown to be effective in returning ponderosa forests to more natural, open and conflagration-resistant conditions (Biswell, et al., 1973; Weaver, 1974; Ffolliott, et al., 1977; Bennett, 1979). Thus, "fire is seen as a management resource or tool" (Barney, 1975). Indeed, the basic policy for dealing with fires on all National Forest Service administered lands was changed in 1977 (Forest Service Manual 5100, 1978) in essence from control to management (Nelson, 1979). This new policy has, as one of its specific major aims, provision for prescription fires, ignited either by plan or naturally, to protect, maintain, and enhance National Forest resources.

Nelson (1979) notes a number of problems associated with the implementation of the new Forest Service fire management policy. First among these problems is: "A public concern over a less-than-all-out (suppression) effort in some areas. The reverse is also a problem. It is a misconception that, since wildfires are a natural ecological process, prevention is not important."

"There is urgent need for the development of vigorous public relations programs, especially local and regional, to acquaint the public with the purposes of controlled burning and the need for maintaining the hazards at low levels ... Due to the development of a highly urbanized population, public programs concerning controlled burning are now especially needed," (Biswell, et al., 1973).

The mandate of the National Forest Management Act of 1976 to involve the public in resource management decisions is clear and unavoidable. Thus, it is important that means be developed now for communicating the present state-of-the-art knowledge of differential effects of distinct categories of fire intensity to the general public.

The Multiple Use Sustained Yield Act (MUSY) of 1960 requires that the National Forests be managed for recreation and scenic quality, as well as for timber, pulp, range, wildlife and watershed protection. The effects of the new fire management policy upon recreation and scenic quality, therefore, also need immediate attention.

Thus, there is significant need in the U.S. Forest Service for the development and testing of public information instruments for relating the effects of both light and severe fire upon forest ecosystems. Simultaneously, there are needed empirical tests of the public's perceptions of scenic quality and recreational acceptability of forest areas exhibiting a range of fire histories.

This study has been designed to develop and test public education instruments which compare the effects, over time, of severe wildfire and light prescribed fire upon southwestern ponderosa pine forests. Recent

U.S. Forest Service research emphasis has been on the development of production functions which relate specific fire effects, over time, to differing fire intensities. Therefore, development and testing of the public information materials concentrated heavily upon fire-effects production functions.

This study has also been designed to test the public's perceptions of both recreational acceptability and scenic quality of southwestern ponderosa pine forest areas showing evidence of light or severe fires following one-to-five year recovery periods. These tests, then, can provide the base for development of scenic and recreational fire-effects production functions. Comparisons between information provided and assessments for scenic or recreational quality should lend insight into how forest fire information programs might influence public perception of burn areas.

CHAPTER II

LITERATURE REVIEW

To develop appropriate public information materials, a review of the literature pertaining to the effects of fire on southwestern ponderosa pine forests was required. In addition to the usual parameters (effects on flora, fauna, soils and erosion, water, and air quality), reported effects of fire on scenic quality and recreation were also reviewed. Although effects on scenic quality and recreation were not included in the public information materials, investigation of the impact of fire on these two parameters was a major portion of the overall study plan. Literature pertaining to the relationships between information and perception -especially relating to fire or forest information - was reviewed in preparation for the experiment which involved provision of fire-effects information and subsequent perception testing. Some literature concerning the relative effectiveness of different kinds of mass communication was also considered.

The Effects of Fire on Ponderosa Pine Forest Types of the Southwest

Effects of Fire on Flora

Succession. The correlations between periodic fire and ponderosa pine forest types in the southwest have already been mentioned. Throughout much of its range, a ponderosa dominated forest type is

essentially a fire-climax community. The more shade tolerant, coexistant species tend also to be more fire susceptible. Ponderosa, thick barked and, when mature, often bearing crowns that start relatively high off the ground, tend to be much more resistant to light or moderate burns (Martin, et al., 1979). Ponderosa litter tends to be highly flammable, and when needles and debris catch in understory vegetation, they increase the fire susceptibility of the potentially competitive species. The survival and recovery potentials of ponderosa relate directly to fire intensity and flame height (Biswell, et al., 1973; Dieterich, 1979). Bennett (1979) found that prescribed burning of ponderosa forests on the north rim of the Grand Canyon increased the relative dominance of Pinus ponderosa, while reducing dominance for Abies concolor and Populus tremuloides.

Fuels. Quantitative data have been recorded for pre-burn fuel loading, fire intensity, and post-burn fuel loading for both prescribed and wildfires in ponderosa pine forest types (Campbell, et al., 1977; Ffolliott, et al., 1977; Lindenmuth, 1962; Martin, et al., 1979). These data do not show simple relationships, however, since fuel-fire intensity interactions are greatly affected by such factors as fuel moisture content, relative humidity, ambient temperature, slope and wind speed (Brown and Davis, 1973). Such multivariant interactions are difficult, at best, to communicate to the general pubic. However, a cyclical, feedback relationship between fire intensity and fuel loading can be demonstrated.

Microflora and Disease Organisms. Wells, et al. (1979) summarize effects of forest fire on microflora, in part, as:

> Heat from fires has a temporary sterilizing effect that may improve plant growth. Prescribed burning for 20 years alters microorganism populations but essential soil processes are not impaired. ... host parasite relations were altered - one negatively and one positively. Fungi are more easily destroyed by heat than are bacteria, while both groups are affected more ... in wet soil ... Nitrifying bacteria are killed at low temperatures ... (p. 27)

Bennett (1979) suggests that creation of ash increases soil pH to a level more optimum for bacterial organisms (approximately 6.5) while creating a less advantageous environment for fungal organisms (optimum pH levels about 4.5). He estimates that post-prescribed-burn, gross microflora metabolism effects are a 250 percent increase. Such an increase would hasten decomposition thus slowing the rate of forest litter accumulation which Bennett estimates to be significant for as long as 19 years.

Bennett (1979) also found a strong direct correlation between USFS mistletoe infection rating and fire-kill of infected trees. Thus, fire may show some potential for reduction in the spread of mistletoe infection. Weaver (1974) suggests that a positive, although less direct, control of the rate of infection by western pine beetle may also be accomplished through the use of prescribed fire.

Forage. In general, periodic fires are felt to improve forage and range in ponderosa pine forests through reduction of needle mats and debris that tend to inhibit grass and forb production (Weaver, 1974). Lupine and pine grass are stimulated, and woody shrubs that are killed to ground line produce more tender growth available to browsing animals.

Ffolliott, et al., (1979) however, found negligible effects on grazing values on two prescribed burn plots in ponderosa pine forests in

northern Arizona. Both plots were burned at very light intensities, estimated to be 48 and 90 BTUs/sec/ft.

Campbell, et al., (1977) reported three-fold increased forage production on both moderate and severe wildfire areas two years after fire. Herbaceous species composition had approached original conditions on the moderate burn while the severely burned area continued to show successional changes.

Effects of Fire on Soils

All soil properties affected by fire relate to the relative amount of heat exposure (Wells, et al., 1979). Severe fires that consume all litter and duff, leaving the mineral soil surface exposed, can decrease infiltration and aeration as well as increase raindrop-impact soil dispersion. Incomplete consumption of surface organic matter effects little change in pore space and infiltration rate. Zwolinski (1971) found that both heavy and light burns produced significant reductions in forest soil infiltration capacities, but these returned to normal after overwintering because of frost action on texture and porosity. Cooper (1961) reported that although some post-prescribed-burn soil movement was evident in Fort Apache ponderosa pine, restabilization was achieved nine months after burning. He considered the overall influence of prescribed burning on watershed condition to be relatively slight.

Exposure, by severe fire, of soil mineral surfaces can raise subsurface soil temperatures. The temperature differential between exposed and unexposed soils at 5 cm depth is about 10^{o}C. Restoration of

vegetative cover quickly decreases this differential. Prescribed burns over well-developed forest floors produce soil surface temperatures usually less than 100°C, and only slight temperature changes at 5 cm (Wells, et al., 1979). Fires can cause water-repellent layers in forest soils at the surface or as deep as 20 cm, especially in dry coarse soils (Wells, et al., 1979; Zwolinski, 1971).

Reports on the effects of fire on nutrient cycling are mixed and in some instances contradictory. Wells, et al., (1979) report that, in general, P, K, Ca, and Mg are increased immediately after burning and N decreases through volatilization. They estimate 10 to 20 percent N loss for ponderosa pine forests. Both Ryan (1978) and Harris (1978), however, found overall increases in available nitrogen subsequent to prescribed burning in ponderosa pine forests.

Effects of Fire on Water

The most significant fire effect on water relates to the effects on vegetative cover and soil, and thus is correlated with relative fire intensity. Significant reduction of vegetative cover, litter and duff and exposure of mineral soil, particularly where non-wetable soil layers are produced, increases overland flow, peak discharge and overall discharge. These changes in water movement characteristics increase erosion and sediment discharge into water bodies. "Sedimentation, increased turbidity levels, and mass erosion appear to be the most serious threats to water resources following fires (especially wildfire)" (Tiedemann, et al., 1979). Some threat to aquatic wildlife, although apparently not to benthic organisms, may result from increased water

temperatures through elimination of stream bank cover by fire. Although, to date, there has been insufficient quantitative correlation, larger, higher intensity fires have shown the greatest potential for erosion and water resource damage. Light intensity fires show little measurable change in water resource quality, particularly following a year's recovery cycle.

Effects of Fire on Fauna

Research on the effects of fire on vertebrate wildlife, as reported by Bendell (1974) and Lyon, et al., (1978) shows highly mixed, and sometimes conflicting results. This may be largely due to the variability in the length of time-after-burn when studies have been conducted, and the lack of correlation of results with relative fire intensity.

Most significant, perhaps, of the research findings is the evidence that direct effects of fire on most mammal and bird populations are slight. Direct fire kill is reported to be quite low, but some population changes occur due to habitat change following severe fire in ponderosa forests. Bendell (1974) reports from the literature that the majority of bird and mammal species do not demonstrate significant changes in either population density or trend as a result of fire. This may be due, in part, to the fact that fires seldom burn evenly, and post-fire conditions retain broad spread ecosystem diversity. Secondly, faunal species found in fire-climax ecosystems may be adapted to the recurrence of fire. A mechanism for such adaptation, suggested by Shafi and Yarranton (1973), is that the fauna of fire-climax systems may be less

specialized and more broadly adapted than fauna of more stable climax communities.

Mammals. In broadly generalized terms, fire may favor populations of deer, elk, cougar, coyote, black bear, beaver, hare, turkey, pheasant, bobwhite quail, some water-fowl, and the grouse: sharptail, prairie chicken, ruffed, and blue. Conversely, fire may tend to decrease populations of martin, red squirrel, grizzly bear, fisher, spruce grouse and heath-hen (Bendell, 1974).

Campbell, et al., (1977) measured increases in population density of deer, white-footed mice, deer mice and golden-mantled ground squirrels on two intensities of wildfire in north-central Arizona. Chipmunks demonstrated a measurable decline, but patterns of use by elk were not statistically verifiable. Beneficial effects of wildfire for both deer and elk populations in southwestern ponderosa forests have been reported by Lowe, et al., (1978), Lowe (1975), and Kruse (1972). Lowe (1975) also reports beneficial effects for deer and elk from light or prescribed fires, although somewhat lesser than those resulting from wildfire. Tree-dependent rodent species, such as chipmunk and Abert squirrel, can be adversely affected, particularly by wildfire effects (Lowe, et al., 1975; Patton, 1977).

Birds. The effects of fire on bird populations in southwestern ponderosa pine depend greatly upon the feeding and nesting habits of the bird species, and on the timing and intensity of the fire. Fires that occur during nesting seasons, generally early spring, can be expected to have the greatest impact on bird populations. Forest-adapted species,

such as nuthatches, chickadees and warblers, generally decline in numbers following severe fire, whereas brush and ground-foraging species such as bluebirds, towhees, robins and turkeys increase (Lowe, 1975; Lowe, et al., 1978).

Effects of Fire on Air

Forest fires, both prescribed and wildfires, impact local air quality, particularly visibility reduction from particulate emissions. Experimental evidence from Australia (Vines, 1973) and from the southeastern United States (Cooper, 1973) demonstrates that prescribed burning emits into the atmosphere suspended particulates, CO_2, CO, and HC. SO_x were not detectable as forest fire emissions and NO_x are generated only by high temperature (severe) fires. No detectable changes in O_3 levels occurred, thus photochemical smog should not result from forest burning. Vines concludes that reduced visibility (smoke) is the most undesirable feature of large prescribed fires.

Combustion emissions generally are significantly lower from dead, dry forest fuels (light to moderate prescribed burns) than from live, green material (severe wildfires). With prescribed burning, managers can select atmospheric conditions such as to reduce gasseous emissions to 20 percent of potential wildfire levels (Cooper, 1973).

Komarek (1973) points out that atmospheric carbon particles act as condensation nuclei to initiate cloud formation and precipitation. Considering evidence that 300,000 tons of carbon particles have been emitted into the global atmosphere per year for approximately 100 million

years by forest fires, Komarek suggests the need for a more detailed "taxonomy" and study of behavior of atmospheric carbon.

This state-of-the-art fire-effects information was used to develop graphic production functions to be used in pilot, public information brochures (see Appendix A). The production functions show generalized relationships between various forest resource components, fire intensity and recovery time. Following a suggestion by Mr. John H. Dieterich (Forest Sciences Laboratory, U.S.D.A. Forest Service, Tempe, Arizona) that these functions should relate directly to U.S. Forest Service policies for multiple-use resource management, fire-effects functions were developed as shown in Table 1. The literature which contributed directly to the development of these forest-resource production functions is also included in this table.

Effects of Fire on Scenic Quality

In a recent survey of 17 English language journals in the disciplinary fields of Landscape, Forestry, Recreation, Geography, Interdisciplinary/Environmental Studies and Human Behavior (Zube, Sell and Taylor, in press), 160 landscape perception articles were found for the 16-year period, 1965 through 1980. Of these, 23 perception of landscape articles had been published in U.S. and British forestry journals. All but one of these forestry-journal articles were based either upon expert judgement -- professional landscape or silvicultural taste -- or upon empirical tests of psychophysical, stimulus-response relationships assumed to underlie the perceptual judgement of forest landscapes by humans.

TABLE 1

FIRE-EFFECTS FUNCTIONS: THEIR ASSOCIATED RESOURCES AND LITERATURE

Management Resource	Production Function	Primary Literature Sources
Timber Production	Effects of Fire on Tree Growth · Ponderosa Pine · Competing Species	Bennett, 1979; Lowe, 1975; Morris and Mowat, 1958
Forage Production	Effects of Fire on Forage · Grasses · Shrubs	Bennett, 1979; Fitzhugh, Cornley and Beaulieu, 1978; Lowe, 1975; Lowe et al., 1978; Wright, 1978
Wildlife Management	Effects of Fire on Mammals · Elk · Deer · Chipmunks and Tree Squirrels	Campbell et al., 1977; Fitzhugh, Cornley and Beaulieu, 1978; Kruse, 1972; Lowe, 1975; Lowe et al., 1978; Lowe et al., 1975; Lyon et al., 1978; Patton, 1977
	Effects of Fire on Birds · Forest Adapted Species · Brush and Ground Foraging Species · Woodpeckers	Bendell, 1974; Campbell et al., 1977; Lowe, 1975; Lowe et al., 1978
Watershed Management	Effects of Fire on Watersheds · Surface Runoff · Erosion · Sedimentation	Campbell et al., 1977; Cooper, 1961; Rowe, Countryman and Storey, 1954; Tiedemann et al., 1979; Wells et al., 1979; White and Wells, 1979; Zwolinski and Ehrenreich, 1967
Air Quality Management	Effects of Fire on Air Quality · Forest Fire's Contribution to Air Pollution in the U.S. · Forest Fire Particulate Production by Season, Rocky Mtn. Region	Cooper, 1973; Cramer, 1975; Dieterich, 1971; Murphy, 1972; Sandberg et al., 1979; Vines, 1973

Of the 160 landscape perception articles surveyed, 32 dealt with aspects of forest scenic quality and an additional 7 articles dealt specifically with forest recreation. Of these 39 forest-landscape perception articles, 35 were based on either expert or psychophysical methods and only 4 had a cognitive methodological basis --concerned with the meaning of forest-landscape perception. Of the forest-landscape perception articles surveyed, none were "experientially" based - that methodological approach which views the perception interaction as the appropriate focus for research, with some prevalence in Psychology (eg: Ittelson and Cantril, 1954) and Geography (e.g., Lowenthal, 1978; Tuan, 1974). Table 2 references the 39 forest-landscape and forest-recreation perception articles according to the methodological basis utilized and by the journal discipline within which each was found.

That some 90 percent of the forest perception articles in the United States and Britain have had expert or psychophysical bases is not surprising. Much of this research has been in response to legislative mandates (eg: the British "Countryside Act of 1968;" the U.S. "Multiple-Use Sustained-Yield Act of 1960;" the U.S. "National Forest Management Act of 1976") to conserve natural beauty. Research within both the expert and psychophysical paradigms has concentrated on pragmatic, field-applicable scenic quality evaluation, whereas searches for an understanding of the meaning (cognitive) of perception or the nature of the interactive perceptual event (experiential) have yielded little, to date, which could be put to use in management of scenic quality (see Zube, Sell and Taylor, in press).

TABLE 2

SOURCE AND METHODOLOGICAL BASIS FOR JOURNAL ARTICLES ON FOREST LANDSCAPE PERCEPTION: 1965-1980

Methodological Basis / Journal Discipline	Expert	Psychophysical	Cognitive	Experi-ential	Totals (by Journals)
Landscape	Clay, 1965; Murison, 1965; Van Duesen & Egler, 1965; Williamson et al., 1978	Williamson & Calder, 1979	Saurin, 1980		6
Forestry	Burke, 1975; Goodier & Ball, 1974; MacDonald, 1969; Matthews, 1967; Nickerson, 1979; Rudolf, 1967; Twiss, 1969; Wagar, 1975; Wigg, 1969; Workman, 1974; Streeby, 1970	Arthur, 1977; Brush, 1979; Buhyoff & Leuschner, 1978; Buhyoff et al., 1980; Hancock, 1973; Levine & Langeneau, 1979; Peterson, 1974; Rutherford, & Schafer, 1969; Sidaway, 1977; Yarrow, 1966	Yeiser & Schilling, 1978		23
Outdoor Recreation		Buhyoff & Reisenman, 1979; Buhyoff & Wellman, 1980; Cook, 1972; Daniel et al., 1978			4
Interdisciplinary Environmental	Goodall & Whittow, 1980; Rasmussen et al., 1980		Buhyoff, Leuschner & Wellman, 1979		3
Behavioral		Schroeder & Daniel, 1980; Schafer, 1969	Simpson et al., 1976		3
Geography					0
Totals (by Methods)	18	17	4	0	39

Early research concerning scenic quality of forest landscapes in the United States had two major thrusts: descriptive, non-quantitative inventories of landscape features based on design components such as unity, dominance, color, contrast, depth of field, etc., drawn from the profession of landscape architecture (e.g., see Litton, 1968 and 1974; Litton and Twiss, 1967) and forest landscape component models developed by E.L. Shafer, Jr., and his colleagues which combine public preference surveys with landscape feature inventories (e.g., see Shafer, 1969; Shafer and Brush, 1977; Shafer, Hamilton and Schmidt, 1969). Critiques of these earlier forest-landscape assessment techniques (Arthur, Daniel and Boster, 1977) point out several problems: whether component analysis can be used to explain the whole of scenic quality; whether professional judgements necessarily parallel public judgements; and that unity, dominance, or proportion of foreground vegetation are difficult terms to interpret or apply in the manipulation of forest components to achieve scenic quality.

Much of the more recent research in perception of forest scenic quality has focused on specific forest resource components which are potentially manipulable by forest managers. Buhyoff and his colleagues, for example, have reported extensively on the aesthetic impacts of southern pine beetle damage (Buhyoff and Leuschner, 1978; Buhyoff, Leuschner and Arndt, 1980; Buhyoff, Leuschner and Wellman, 1979; Buhyoff and Riesenman, 1979).

Daniel and his colleagues have applied signal detection scaling techniques to scenic beauty evaluation scales to yield fundamental scenic

quality estimation values for areas as perceived by human observers (Daniel et al., 1973; Daniel and Boster, 1976). This scenic beauty estimation (SBE) technique has been applied to selection of scenic forest road corridors (Shroeder and Daniel, 1980), to assessment of scenic impacts of alternative logging procedures (Benson, 1974), to assessment of public sensitivity to alternative watershed treatments (Boster and Daniel, 1972), for testing linear regression models for scenic beauty prediction (Arthur, 1977), and for mapping of scenic forest areas (Daniel et al., 1977) as well as to some non-forest applications. Most recently, the SBE method has been applied to assessment of visual air quality (Latimer, Daniel and Hogo, 1980) and the scenic effects of prescribed burning in ponderosa pine (Anderson, Levi, Daniel and Dieterich, in press).

Qualitative aesthetic comparisons of fire-suppression, wildfire, and prescribed fire areas abound (e.g., see Biswell, et al., 1973). Weaver (1974), referring to dense forest growth resulting from complete fire supression in ponderosa pine forests, asks, "What beauty is there in monotonous, dense, stagnated, debris-littered jungles, where there is nothing to attract animals or most bird life?" Alternately, C.E. Dutton (1887), in his description of a ponderosa forest on the Kaibab Plateau that had experienced a natural fire incidence, states:

> The trees are large and noble in aspect and stand widely apart ... Instead of dense thickets where we are shut in by impenetrable foliage, we can look far beyond and see the tree trunks vanishing away like an infinite colonade. The ground is unobstructed and inviting. There is a constant succession of parks and glades - dreamy avenues of grass and flowers winding through sylvan walls, or spreading out in broad open meadows.

While such comparative descriptions are common in forest literature, the study mentioned above by Anderson et al. (in press) is the only empirical study found, to date, which specifically relates scenic quality to the effects of fire in forests.

The results of this study, that a rapid scenic quality recovery may occur following prescribed light fire, directly pertain to the present project. However, to date, the author has found no empirical studies which relate the comparative scenic quality impacts of light and severe forest fires.

Effects of Fire on Recreation

In their Study Plan for the Eisenhower Consortium funded project to evaluate public response to the use of prescribed fire in recreational land management, Cortner, et al., (1979) state, "Little previous research has systematically investigated public knowledge and attitudes toward fire management" (in a recreational context).

The relationship between recreation and fire has most generally been assumed to parallel some other interaction dimension, such as the relationship between fire and scenic quality. Wagar (1974), in discussing recreational and aesthetic considerations of forest residues management, deals specifically with aesthetic amenity values and impacts. Dimensions such as naturalness, imageability, legibility, texture, harmony, scale and order are considered as visual aesthetic factors in management for both visual and recreational amenities. Only under "passability" (i.e., openness to human passage) is outdoor recreation

given direct consideration. Rudolf (1967), in discussing silviculture for recreation area management, specifically equates proper management for recreation with proper management for visual quality.

Perkins (1971) makes the assumption that the effects of prescribed fire on outdoor recreation parallel the effects on plant and animal species composition. He argues that since most recreation activities are dependent upon the presence of specific species (hunting, birdwatching) or upon species diversity (nature study, photography), forestry practices which enhance appropriate species composition will by definition enhance recreation. Thus, hunting, camping, picnicking, hiking, birdwatching and outdoor photography are all assumed to benefit from prescribed burning.

Connaughton (1972) states that in general, the immediate effects of fire on forest recreation are negative and severe, but some secondary effects may be positive. Immediate fire effects include fire danger and immediate aesthetic damage. Possible positive effects on recreation include such activities as berry-picking and big game hunting. The latter could be enhanced through game species population responses to increased browse following fire.

All of these studies are based upon assumed relationships between recreation and other forest dimensions. Whether these relationships indeed exist remains to be empirically tested. As has been pointed out by Jack Ward Thomas (1981), it has taken years to establish that optimum silvicultural practice does not necessarily imply optimum wildlife management. A similar difficulty may well exist in the relationship

between silvicultural practice and recreation in that optimum forestry may not necessarily produce optimum recreation opportunities. Indeed, the often assumed relationship between visual quality and recreation has not been empirically demonstrated.

Two empirical investigations of the relationship between forest fire and recreation deserve attention here, that by Stankey (1976) and that by Rauw (1980). Stankey investigated wilderness users' knowledge and attitudes concerning fire in wilderness settings. This sample's performance on the knowledge of fire-effects portion of the survey was generally low; the average score was 53 percent correct response. Knowledge about fire was especially low regarding the size of pre-Columbian forest fires, increasing conflagration potential through fire suppression, the effects of fire suppression on habitat, and the relation of fire to animal death. In attempting to define what variables explain attitudes toward fire suppression policy in wilderness areas, age, number of visits, education, and fire-effects knowledge were examined. Of these, age, number of visits, and education showed no significant correlation with fire management attitudes. However, "there was a strong correlation between the test score and the (attitude) statements selected as acceptable ... knowledge of the individual's test score explained nearly 60 percent (.57) of the variance in the selection of the 'most acceptable' statement" regarding fire suppression policy. Essentially, the more that wilderness users know of the effects of forest fire, the more willing they are to tolerate it in a wilderness setting. From this, Stankey draws the management implication that "Garnering public support

for modified (fire) suppression policies seems closely linked to educating the public to the role of fire in forest ecosystems" (including wilderness areas).

Rauw investigated fire knowledge and attitude related to the Olympic National Park among park visitors and peninsula residents. Nearly half of the 725 respondents reported having been in or near a forest fire at some time, although few had received any personal losses due to fire. Rauw reports that the fire knowledge results suggest that recreation area users and residents are aware of beneficial effects of certain fires, recognize evidence of past fires, know that certain fires cannot be suppressed, and that over 70 percent correctly defined the practice of prescribed burning. Concerning fire attitudes, however, Rauw reports that 65 percent of the sample "felt that all fires should be controlled at any cost," despite the fact that fire is recognized as having some beneficial effects on natural resources, and that support was evidenced for prescribed fire for hazard fuel reduction and restoration of native vegetation. "This realization does not seem to connect itself to the actual management alternative that is necessary in order to restore the natural process of fire to the land."

The Relationship of Knowledge and Perception

J. Alan Wager (1974), in discussing recreational and aesthetic effects of forest residues management, states, "Perception depends greatly on what people know and believe. Therefore, studies are needed to determine how perception of landscapes and forest debris changes as people are supplied with explanations of what they are seeing." Zube and

Pitt (1981) found significant differences in scenic judgment across cultures and subcultures, especially regarding tolerance for man-made structures in natural landscapes. However, Zube (1973) reported high correspondence in both scenic evaluation and semantic differential scaling among designers, resource managers, environmental technicians, wives, teachers and secretaries. Zube and Pitt (1981) conclude, "perceptual responses are conditioned by learning and learning varies with culture and environment." Correlated to Zube's 1973 report is the finding by Buhyoff et al. (1978) that landscape architects can replicate "client" perceptions, given written descriptions of the clients' likes and dislikes. However, preliminary evidence for one important difference between designers (especially design students) and other public and professional groups was pointed out by Zube (1973). Design students rated drawings of landscapes as essentially equivalent to slides of the same landscape scenes. Although other subjects apparently did perceive drawings as landscapes, they rated them differently than they did slides of those landscape scenes. Zube points out, "This obviously raises serious questions about the utility of using drawings interchangeably with photographs for communicating the essence of environmental change," (page 95).

Beckett (1974) studied the relationship between scenic assessment and knowledge. Knowledge levels were determined by having respondents rate themselves in terms both of knowledge of rural economy and of aesthetic awareness. Aesthetic assessment was measured by having respondents rate their "degree of outrage" if a "conspicuous red house,

surrounded by the stock-in-trade of a scrap merchant" were placed in the center of rural scenes being evaluated. Beckett concludes, "one's aesthetic appreciation of a landscape is affected by one's knowledge. One likes what one thinks one understands, even if ... the landscape is unfamiliar."

Familiarity, as a portion of knowledge affecting perception, has been investigated by Wellman and Buhyoff (1980) who found no significant regional-familiarity effect in evaluations of mountain landscape quality. Both Utah and Virginia residents rated Rocky Mountain and Appalachian scenes without demonstrating preferences with their more familiar areas. Conversely, Nieman (1980) found familiarity to be highly influential in evaluations of visual quality of New York coastal areas. Sonnenfeld (1969) also found home area preference expressed among Alaska natives, non-natives and Delaware residents, although these preferences diminished in strength as the degree of outside experience increased. That familiarity should positively affect scenic preference corresponds with the findings of numerous geographers studying regional preferences through cognitive mapping (eg: Gould and White, 1968; Hanson, 1973).

Peterson (1974) studied knowledge and preferences of managers and canoeists in the Boundary Waters Canoe Area. He found managers to be more knowledgeable than canoeists as well as more "purist" or restrictive towards improvements; while canoeists were more "purist" in regards to natural features of the area and to intolerance of competing uses.

A number of researchers have studied the effects upon perception of the manipulation of knowledge. Buhyoff and his colleagues, using

paired-comparison scenic evaluations, have demonstrated that subjects who have been informed that they will be observing forest scenes "with insect damage present" show greater aesthetic loss corresponding to pine beetle damage than do naive subjects (Buhyoff, Leuschner, and Wellman, 1979); and informed subjects will key to a specific dimensionality, eg: insect damage (Buhyoff and Reisenman, 1979).

Yeiser and Shilling (1978) used galvanic skin response equipment (lie detector equipment) to test emotional responses of students, with varying degrees of knowledge concerning forestry practices, to different combinations of scenes and terms. Included were scenes of charred slash and control burns as well as the terms "pile and burn" and "fire." These researchers found response intensity to correlate inversely with the numbers of reasons given, ie: that more reasons are offered for weaker emotional responses. They also found that subjects without knowledge tend more to respond to term connotation than do knowledgeable subjects. In a related study, Hodgson and Thayer (1980) manipulated labels on a set of slides to imply greater ("reservoir, irrigation, road cut, tree farm") or lesser ("lake, pond, stream bank, forest") human influence. They found consistently higher ratings for scenes given more "natural" labeling than for those implying more human manipulation, even though the scenes themselves remained unchanged.

Simpson et al. (1976) compared the effects of providing a model's ratings, reported norms of others' ratings, and a persuasive ecological message upon the scenic ratings of forest scenes. One hundred twenty women rated slides of natural, thinned, and clearcut forest areas before

and after the diverse influence treatments. These researchers found that provision of the ecological message plus either the model or norm rating produced the greatest increase in tolerance to the forest management practices shown. Clearcut, the least-liked and information targeted landscape, showed the greatest shift in scenic quality assessment. Thinned second and natural areas showed the least change. They conclude that "the combination of accurate information realistically endorsed by an authoritative source might be an optimal influence tactic."

Anderson (1978) found that some shifts in scenic quality judgment, although relatively weak, could be effected through administration of short communications concerning "downed wood" and "tree density." The stated source of the information showed no effect upon scenic quality judgments, and only one-sided or biased messages (presenting only one side of an argument) produced reliable increases in scenic evaluations. Anderson also tested the effects of labeling scenes as did Hodgson and Thayer (cited above). Anderson (1978) found that attaching the labels "wilderness area" or "national park" consistently raised the scenic beauty estimation values of forest scenes, while attaching the labels "commercial timber" or "leased grazing" consistently lowered scenic beauty estimation values.

Anderson concludes, from the results of her information treatment study, that trade-off oriented, two-sided messages (presenting both sides of an argument), more likely to be used in public information and education programs by governmental agencies, should not be expected to effect significant changes in scenic quality evaluation. However,

Hovland, Janis and Kelley (1953) report experimental results demonstrating that two-sided arguments are more effective than one-sided for more intelligent audiences, for persons initially disagreeing with the position forwarded, and for longer periods of time. Hovland et al. also report that the general argument is retained for a longer period than are the specifics, and that role playing enhances the acceptance and retention of a position. The latter finding underscores the finding by Simpson et al. that a combination of accurate information and a role model evaluation can be quite effective in achieving acceptance of resource managers' practices. Faison (1961), in reporting the effectiveness of one-sided and two-sided mass communications in advertising, draws the following conclusions: upper-intelligence-level subjects were more influenced by two-sided arguments; lower-level subjects were more influenced by one-sided arguments. For subjects initially opposed to the position presented, the two-sided argument had more favorable results; for subjects initially favorable, the one-sided argument was superior. The two-sided arguments were significantly more effective than the one-sided arguments in influencing attitudes four to six weeks following their presentations. Finally, Faison notes that the more knowledge a person has about a given subject, the less influential will a communication, either one-sided or two-sided, be in altering his or her opinion. Thus, both Hovland et al. and Faison suggest that two-sided arguments are more effective in communication than are one-sided communications. However, a note of caution is suggested by Hass and Linder (1972) in that when a two-sided argument is used, if the

counter argument is inadequately refuted one can easily achieve an effect opposite to that intended.

In the natural-resource-persuasion experiments cited above (Anderson, 1978; Buhyoff et al., 1978: Buhyoff, Leuschner and Wellman, 1979; Buhyoff and Reisenman, 1979; Hodgson and Thayer, 1980; Simpson et al., 1976; and Yeiser and Schilling, 1978), information was presented and perception or preference subsequently tested. In none of these studies was information retention specifically tested. As a portion of his experiment, Rauw (1980 - cited above) administered an eight-question fire quiz before and following a slide tape program, "Fire: an Olympic Event," designed to increase public understanding of the role of fire and changes in fire management policies. Rauw found a consistent increase in number of correct answers per respondent and in the number of respondents correctly answering each question on the post-test, with the exception of one question which he concludes to have been poorly worded. Rauw's study, however, did not involve testing changes in perception. The present study is designed to test fire knowledge, fire attitude, and perception of both visual quality and recreational acceptability of forest areas showing different fire histories; subsequent to administration of varying fire-effects information treatments.

CHAPTER III

METHODOLOGY

Objectives and Procedures

The objectives of the present project were:

- to construct public education and involvement instruments using production functions relating fire intensity to vegetation, wildlife, watersheds, soils, and air quality;
- to test the effectiveness of the education and involvement instruments in communicating the effects of two general intensities of fire in southwestern ponderosa pine forests;
- to determine the perceived scenic beauty and recreational acceptability of ponderosa pine forest areas exhibiting different periods of recovery from the two fire intensities; and
- to determine the effects of fire knowledge upon scenic beauty and recreational acceptability evaluation as well as upon attitudes toward management policies for fire in ponderosa pine forests.

To achieve these objectives, four levels of fire-effects information were developed for comparative evaluation; ponderosa pine forest areas in Arizona exhibiting severe and light fire effects with one-

to-five years of recovery were photographed; a questionnaire was developed, coordinated with another fire-attitude survey, for evaluation of the information instruments; a convenience-sample of the general public was drawn and tested; and statistical analyses were conducted of the resultant data. An overview of the experiment is presented in Table 3.

Educational Materials and Evaluation Instrument

The effects that fire has on forest ecosytems vary greatly from one forest type to another. The present study, therefore, was limited to Forest Type 237, Interior Ponderosa Pine where "Pinus ponderosa is pure or predominant, often nearly pure," (Society of American Foresters, 1954). For public communication purposes, the "visual characterization" classification system of fire intensities, presented in Effects of Fire on Soils (Wells, et al., 1979) was used:

> Light Burn 1. Duff and litter are scorched but not altered over the entire depth; black ash and 350°F maximum temperature at the soil surface. 2. Less than 40 percent of brush canopy remains. Irregular and spotty burning, some leaves and small twigs remain on brush unharmed or slightly singed.
>
> Moderate Burn 1. Litter and duff are charred, underlying mineral soil is not visibly altered; bare soil seed bed and 750°F maximum temperature at soil surface. 2. Between 40 and 80

TABLE 3

OVERVIEW OF THE EXPERIMENT

Steps						
A) Investigate Fire Effects	B) Develop Information Treatments	C) Develop Questionnaire	D) Photograph Southwestern Ponderosa Pine Forests	E) Obtain Sample Population	F) Experimental Procedures	G) Data Analysis
Fuel loading relationships Tree growth Forage Wildlife Watershed Air Quality	1) Production function graphs 2) Line drawings 3) Combination "full information" 0) "Control" general forestry information	Test fire knowledge Test fire attitudes	1-5 years recovery · from light fire · from severe fire	Convenience sample from · church groups · civic organizations	1) Read information treatment 2) Evaluate slides · scenic quality · recreational acceptability 3) Answer questionnaire	SBE's RAE's ANOVA Correlation analysis

percent of plant canopy is burned, remaining charred twigs are greater than 0.25 to 0.5 inches in diameter.

Severe Burn 1. Organic layer is consumed, mineral soil structure and color are visibly altered; white ash seed bed, temperatures at the soil surface may exceed 950°F. 2. Complete burning, remaining plant stems are 0.5 inches, or greater, in diameter or only charred, large plant stems may remain.

Extending these criteria for classification of larger areas, or even entire fires is done according to percentages of area lightly, moderately or severely burned:

Light Burn - less than 2 percent severe, less than 15 percent moderate.

Moderate Burn - less than 10 percent severe, more than 15 percent moderate.

Severe Burn - more than 10 percent severe, more than 80 percent moderate.

Two of the latter fire intensity levels were selected for communication of fire-effects to the general public: light burn - typifying the effects of controlled, prescribed burns, and severe burn - typifying the effects of a conflagration fire on a ponderosa forest. These fire intensities were then related in short, parallel narrative

form to fuel accumulation and the effects of such fires on vegetation, wildlife, watersheds and air quality. Production functions were constructed, relating resource response over time to fire by intensity for the following, multiple-use forest management categories: timber production for ponderosa pine and competing species; forage production of grasses and shrubs; wildlife populations including elk, deer, chipmunks and tree squirrels, woodpeckers, forest-adapted bird species and brush and ground foraging bird species; watershed parameters including runoff, erosion and sediments; and the air quality parameters - carbon monoxide, suspended particulates, hydrocarbons, oxides of nitrogen, and sulfur dioxide.

The production function mode of portraying fire effects was selected in response to a stated interest by the U.S. Forest Service in this form of communication. For purposes of comparing the relative effectiveness of production functions, a second mode of portraying fire effects was required. Although Zube (1973) has suggested that drawings may not be perceived as representing reality well, in communicating information, pictures have long been held to be "worth a thousand words." Two sets of line drawings were prepared, portraying "before," "during," and "after" scenes of light and severe fire in ponderosa pine forests.* The narrative, production functions and line drawings were combined to produce three different information brochures as follows:

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* Special acknowledgement and thanks are offered to Mr. Rick Brokaw and Ms. Willie Cornell for preparation of these line drawings, graphing of the production functions, and for layout of the final information booklets.

Treatment 1 - narrative plus production functions;

Treatment 2 - narrative plus line drawings;

Treatment 3 - narrative plus production functions plus line drawings.

If production functions or line drawings stood out as superior in communicating fire-effects information, that should be revealed by this combination of information treatments.

A fourth information booklet was developed, presenting general ponderosa pine forest management information, without specific emphasis upon fire management. This latter booklet served as an information "control," and is designated as Treatment 0. The four information treatments are included in Appendix A. The narrative, productive functions, line drawings, and general forest management information were reviewed by Dr. Malcolm Zwolinski, School of Renewable Natural Resources, University of Arizona and by Mr. John Dieterich, Forestry Sciences Lab, USDA Forest Service, Tempe, Arizona. Their comments and suggestions were incorporated into the final drafts of the information booklets.

A short questionnaire was developed to allow comparative testing of the effectiveness of the four information treatments. The questionnaire was developed in cooperation with H.J. Cortner, E.H. Carpenter and M.J. Zwolinski, principal investigators for the Eisenhower Consortium Project: "Evaluation of Public Response to Use of Prescribed Fire in Recreational Land Managment." It was felt that by having

questions common to the two projects it would be possible to make valuable comparisons between the two projects' data sets at a later date.

The questionnaire was divided into two sections, one testing respondents' knowledge of fire effects, the second probing respondents' attitudes toward fire management. The fire knowledge and attitude distinction was maintained, in part, to allow comparisons with the survey results of Stankey's (1976) investigation of wilderness users' knowledge and beliefs concerning fire in wilderness areas. Fire-knowledge questions concerned the origins, intensity and extent of fires in ponderosa forests as well as fire effects upon air quality, wildlife, water quality, erosion, and vegetation. Attitude questions probed respondents' tolerance of fire in ponderosa forests according to fire intensity and origin, including intentional burning by foresters. Respondents were asked to rate their information booklets, indicate whether they would read them if received unsolicited, and finally to indicate whether they had been interviewed as part of the Cortner, Carpenter, Zwolinski survey. A complete questionnaire is also included in Appendix A.

Selection and Photography of Appropriate Forest Scenes

In order to provide scenes for scenic and recreational evaluation, ponderosa pine forest areas exhibiting the effects of both light and severe fires were photographed. To control for extraneous variables that might affect scenic and recreational evaluations, a number of criteria were predetermined for appropriateness of sites to be photographed. A relatively restricted time frame was imposed on

photographic visits to control for seasonal variation, especially the relative "browning" of undergrowth vegetation. Stands showing relatively mature, "yellow-pine" were selected, or in cases where older severe fires had essentially removed the tree stands, sites were selected which were known to have had mature, yellow-pine at the time of the fire.

Sites exhibiting one-to-five years of recovery since light fire and since severe fire, plus a control area demonstrated not to have experienced fire in the past 100 years (Dieterich, 1980), were selected by professional foresters of the U.S. Forest Service and of the B.I.A. Forest Service. Inspection of the sites by the author, at the time of photographing, reinforced the selections made by the forest professionals of sites representative of the necessary array of fire-recovery conditions. All sites were in Arizona, and of course all were interior ponderosa pine forests (Forest Type 237) areas at the time of burning. Table 4 indicates the areas photographed, the dates of photography, and the numbers of usable slides obtained. The locations of the National Forests and Indian reservation photographed are indicated in Figure 1.

Two means were employed to avoid introduction of experimenter-bias in the selection of scenes to be photographed. In large burn areas, a compass heading was determined which would run a transect line through the center of the burn area. The transect line was walked, and at each 100-pace interval, a number was selected from a chart of random numbers from 1 to 360. That number determined the compass orientation for the first of four photographs taken from that spot, subsequent photographs taken at 90^{o}, 180^{o} and 270^{o} from the original heading. In small burn

TABLE 4

AREAS PHOTOGRAPHED

Years Since Fire	Severe Intensity Wildfire	Light Intensity Prescribed Fire
1	Wallace Tank, Coconino N.F. (23)* October 13-14, 1980	Odart Burn, Ft. Apache Res. (26) October 6-7, 1980 Fort Valley Experimental Forest [1] (7) Last Chance, Coconino N.F. [2] (39)
2	Bill Williams Fire [3], Coronado N.F. (20) October 29 and November 2, 1980	Bill Williams Fire, Coronado N.F. (23) October 29 and November 2, 1980 Bear Canyon, Coronado N.F. (8) Fort Valley Experimental Forest (4) Last Chance, Coconino N.F. (13)
3	Huffer Fire, Coconino N.F. (23) October 13-14, 1980 Bigelow Fire [3], Coronado N.F. (16) October 29 and November 2, 1980 Second Fire, Coronado N.F. (16) October 29 and November 2, 1980	Tonto Sale, Ft. Apache Res. (12) October 6-7, 1980 Bigelow, Coronado N.F. (13) October 29 and November 2, 1980
4	Twin Burn, Sitgreaves N.F. (30)	Fort Valley Experimental Forest (5) Last Chance, Coconino N.F. (25)
5	Clint Well, Coconino N.F. (12)	Soldier Butte, Ft. Apache Res. (36) October 6-7, 1980 Bear Wallow, Coronado N.F. (20) October 29 and November 2, 1980 Last Chance, Coconino N.F. (17)
100 (control)		Ft. Valley Experimental Forest (50)

*Numbers in parentheses indicate numbers of usable slides.

[1]Fort Valley Experimental Forest slides provided by Forestry Sciences Lab, USDA Forest Service, Tempe, Arizona. Seasonal control was maintained.

[2]Last Chance slides provided by Dr. Terry C. Daniel, Department of Psychology, University of Arizona. Seasonal control was maintained.

[3]Both the Bill Williams and Bigelow Fires, Coronado N.F. contained distinct severe-fire and light-fire areas.

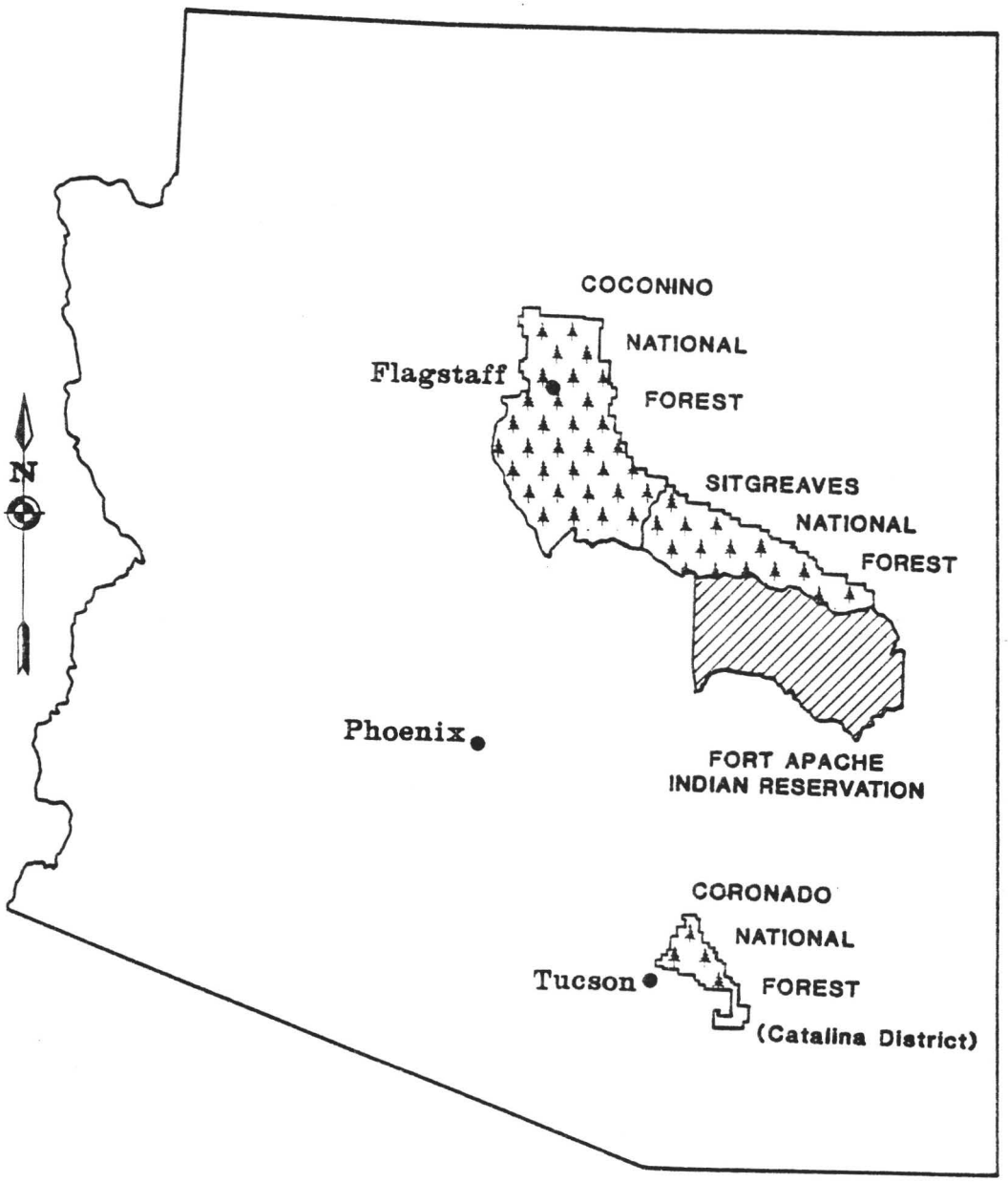


Figure 1. Location Map: National Forests and Indian Reservation Photographed.

areas, the perimeter of the burn was walked, and at each 100-pace interval, one photograph taken, oriented toward the center of the burn.

With the exception of the Fort Valley and Last Chance scenes (see footnotes, Table 3) all photographs were taken by the same experimenter, using the same camera (single lens reflex, 35 mm) with the same lens (55 mm with "daylight" filter). All film was Kodachrome 64 (ASA 64), and all film was processed by the same laboratory (Kodak Laboratory, Los Angeles, California). Photography of the Fort Valley Experimental Forest and the Last Chance Burn, Coconino National Forest, was also done at random orientations, and the Last Chance photography done with the same equipment as the bulk of the experiment.

A final screening was conducted of the 35 mm color slides obtained. Slides that were disproportionately dark, due to camera setting or weather conditions, were removed. For areas with still-standing forest, scenes with at least one or two mature, yellow pines were retained. Slides which showed cultural artifacts, e.g., U.S. Forest Service colored flags and stakes, roads or road-cuts, transmission antennae, or power lines, were removed. Last, a few scenes were removed which showed significant differences in the degree of seasonal browning of underbrush and grasses.

Slides were then sorted into eleven groups according to the two fire intensities, the five different ages of recovery, plus the no-fire control scenes. Slides were selected at random from within each group to create two stratified random samples containing four sets of eleven slides each. Control was maintained, however, to ensure full area

representation within the two slide sets. The order within each stratum was then randomized. The two stratified random sets of slides were then used to obtain: a) scenic quality estimation and b) recreational acceptability estimations. Table 5 shows the utilization distribution of area photographs.

The number of scenes used to represent any single condition was constrained by the overall experimental design. A minimum of two fire intensities was necessary in order to obtain correlation of perception with the effects of different kinds of fire. Five years was also felt to be minimal for demonstrating changes over time, and a no-fire, control condition was experimentally required. Further, if the question of the relationship between scenic and recreational assessment was to be investigated using the same respondents for both evaluations, two separate sets of slides were needed. Thus, twenty-two conditions were required. According to Daniel and Boster (1976), "At an exposure time of 5 to 8 seconds (8 seconds used in this experiment), 100 slides is pressing the upper limit for all but the most motivated" (p. 26). Therefore, only four slide-representations for each of the 22 conditions were allowed, giving a total of 88 scenes to be rated by each participant. The 88 ratings, in addition to the time required for reading the information brochure and answering the questionnaire was indeed observed to be "pressing the upper limit" for some of the participants. Interest remained generally high, as evidenced by the thorough questioning of the experimenter during debriefing sessions, but a number of respondents said they were tired after the 45-minute experimental session.

TABLE 5

DISTRIBUTION OF PHOTO AREAS IN
SCENIC AND RECREATIONAL EVALUATION

Fire Type and Years Since Fire	Area	Scenic Evaluation	Recreational Evaluation
S-1	Wallace Tank, Coconino N.F.	4	4
S-2	Bill Williams Fire, Coronado N.F.	4	4
S-3	Huffer Fire, Coronado N.F.	2	2
	Second Fire, Coronado N.F.	1	2
S-4	Twin Burn, Sitgreaves N.F.	4	4
S-5	Clints Well Fire, Coconino N.F.	4	4
L-1	Last Chance Burn, Coconino N.F.	2	1
	Fort Valley Exp. Forest	1	2
	Odart Burn, Ft. Apache Reservation	1	1
L-2	Bill Williams Fire, Coronado N.F.	1	1
	Bear Canyon Fire, Coronado N.F.	2	1
	Ft. Valley Exp. Forest		1
	Last Chance Burn, Coconino N.F.	1	1
L-3	Tonto Sale, Ft. Apache Reservation	1	2
	Bigelow Fire, Coronado N.F.	3	2
L-4	Ft. Valley Exp. Forest	1	1
	Last Chance Burn, Coconino N.F.	3	3
L-5	Soldier Butte, Ft. Apache Reservation	2	2
	Bear Wallow, Coronado N.F.	1	1
	Last Chance Burn, Coconino N.F.	1	1
C-100	Ft. Valley Exp. Forest	4	4
		44	44

*Slides used in the experiment plus listings of location and compass orientation are held by Dr. Terry C. Daniel, Scenic Beauty Lab, Department of Psychology, University of Arizona.

One group of respondents rated the slide sets in reverse, i.e., rated the recreation slide set for scenic quality and the scenic quality slide set for recreational acceptability, and with all eight slides of the control area included. This arrangement allowed comparison of the baseline control slides of the two slide sets, and direct cross-comparison of the scenic and recreation evaluations.

Selection of the Sample Population

A sample of nearly 200 respondents was drawn from the population of the Tucson, Arizona, metropolitan area. In all instances save one, the respondent groups were drawn to provide a general public cross section. The exception was a fire ecology seminar, tested to obtain expert evaluations for comparative purposes.

A form of convenience sampling was utilized whereby churches and other groups were offered $4.00 per participant in the experiment. Care was taken to avoid sampling in groups or organizations which might hold an organizational stance specifically toward resource management or the use of fire in forest management. Therefore, participation was not solicited among off-road-vehicle clubs, hiking clubs, environmental organizations, etc. Further, since the sampling procedure relied heavily upon participation by church groups, care was taken to include a number of different denominations so as to avoid a disproportionate liberal or conservative bias which might predominate within a single denomination. Group designations and numbers of participants are listed in Table 6.

In general, all four information treatments were intermixed within each sample group. In this way, biases inherent within a

participating organization, or biases inadvertently introduced by the experimenter in handling a group, would not be manifest as spurious correlations of one particular information treatment, but would be equally distributed across all information treatments. The three exceptions to this rule were groups drawn for specific other purposes. The expert group received no information treatment, but did evaluate slides and answer the questionnaire. Their questionnaire results provided a baseline for other participants' answers. One of the two Presbyterian groups answered the questionnaire first then evaluated slides, and thus received no information treatment other than the post-experiment debriefing. This group was drawn for comparison of questionnaire results with the Cortner, Carpenter, Zwolinski telephone survey as a check for bias that might occur with the convenience sample technique. The elementary school teacher group rated the slide sets in reverse, with all eight control slides included, i.e., 48 slides per set. Results of scenic beauty estimation and recreational acceptability evaluation from this group were intended for comparison of scenic and recreation set control slides, and for comparison with one of the aggregated, across-group information treatments. Therefore, all members of the elementary teacher group received the same information treatment; the generalized-forest-management, control booklets.

TABLE 6

GROUPS PARTICIPATING IN EXPERIMENT

Group Designation	Number of Participants
Religious	
Church of God	40
Religious Society of Friends (Quaker)	13
Presbyterian Churches (2)	35
Episcopalian	18
Other	
High school baseball team parents	21
Girls club parents	17
Community group	13
Elementary school teachers	21
Expert	
Fire ecology, graduate seminar	15
TOTAL	193

Procedures of the Experiment

Groups of participants were seated so each person could have a clear view of the projection screen. Stapled booklets and pencils were handed out to each participant; each booklet containing an information treatment, two evaluation score sheets, a list of outdoor recreation activities, and a questionnaire. An example of a complete booklet is included in Appendix A. A standardized set of instructions was used in directing the groups (see Appendix B).

Participants were first directed to read the information portion of the booklet, printed on orange paper. They were informed that different booklets contained different information, and were asked to hold any questions or comments about the information treatments until the end of the session. When all had finished reading the information section, the group was instructed in how to rate the forest scenes for scenic quality or recreational acceptability, depending upon which was being presented first. The fact that the forest scenes represented different fire histories was specifically mentioned. Some of the scenes presented, especially those of severe fire areas, so obviously showed fire effects that it was felt that failure to mention the fact might easily be construed as hiding the purpose of the survey, especially for those participants having just read information on the effects of fire on ponderosa forests.

For scenic quality evaluation, participants were asked to rate each scene presented according to its scenic quality on a scale of 1 to 10, where "1" represented "very low scenic quality" and "10" represented

"very high scenic quality." Responses were mark-sensed on standardized rating sheets. Respondents were asked to mark a rating for every scene shown, and encouraged to use the full range of the 1 to 10 scale. A few preview slides were shown to help participants to become familiar with the process, then the full set of 44 scenes presented for evaluation with the experimenter announcing each slide number to help minimize error.

Recreational acceptability evaluation was conducted in the same manner as scenic quality evaluation, with one major difference. A list of seven kinds of outdoor recreation -- 1) driving for pleasure, 2) picnicking and day-use, 3) nature study, 4) hiking or back-packing, 5) camping, 6) hunting, 7) off-road vehicle use, plus 8) other (please specify) -- was placed in the booklet facing the recreation rating sheet. Respondents were asked to mark on the list the one type of outdoor recreation they would most enjoy in the kinds of forest areas presented. They were then asked to rate each scene shown as to how good it would be for their specific type of recreation. In this case, "1" would indicate the area depicted in the scene would be extremely poor for that kind of recreation and "10" would mean the area depicted would be excellent for that kind of recreation. Again, a rating was to be given for each scene shown, the full range of the scale was to be used, and the experimenter announced the number of each of the 44 slides as they were displayed.

For half of the groups, scenic quality was evaluated first and recreational acceptability was rated second. For the other half, the reverse was true. This allowed analysis to determine if any rating order effects occurred. The following table indicates the mix of rating order

and information treatment obtained. A minimum of 16 participants per cell was achieved.

	Information Treatment			
Order of Rating	0) Control	1) PF* Graphs	2) Line Drawings	3) PF and Line Drawings
Scenic/ Recreation	16	16	16	16
Recreation/ Scenic	16	16	16	16

*PF = Production functions

The participants' final formal activity, following the two scene-evaluation exercises, was to answer the questions on the short-form questionnaire. After the packets had been handed in, the experimenter conducted a debriefing session, explaining the purpose of the experiment, who had funded the research and why, and the make-up of the slide sets. Questions from the participants were then answered to the best of the experimenter's ability. Questions, generally, focused on the nature of the experiment and on the effects of fire on ponderosa pine forest ecosystems.

Data Handling and Analysis

Utilization of the convenience sampling technique did not allow exact control of the numbers of respondents per presentation-order/information-treatment cell. The final "n" per cell obtained ranged

from 16 to 22. Also, occasional respondents experienced some difficulty in filling out the perception response sheets or the questionnaire. In three instances, individual respondents were interrupted during the course of the experiment by a telephone call or other calling.

Elimination of respondents, to allow for an equal-n analysis across all data cells, was achieved by sorting through the respondents' data sheets and removing those showing multiple responses to single ratings or questions, or missing data. Thus, excess data was eliminated without regard for the sample group to which the respondent belonged. By this means, all multiple ratings and multiple answers to questions were removed. However, some missing data points remained, particularly within the cells having low initial n's. These missing data were supplied by substituting the whole-number response closest to the average value for that rating or answer within the order/information-treatment cell. Thus, of over 6,900 scenic quality ratings, 11 were supplied by the method described, or approximately 0.16 percent. The same number of recreation ratings were also supplied. In the questionnaire data, there were also 11 missing data points among the fire-attitude responses. Here, 11 of 790 data points, or 1.4 percent, were generated by averaging the specific question responses across a treatment group. Of the 1,100 fire knowledge question responses, only one had to be supplied through the "average response" method indicated. Four "questionnaire rating" values were missing from the final data set, but these were ignored as those ratings were not included in analysis of variance.

Data analysis involved application of the Scenic Beauty Estimation (SBE) statistical analysis, developed by Daniel and Boster (1976), to both the scenic quality and recreational acceptability ratings; as well as application of analysis of variance to the scenic quality ratings, the recreational acceptability ratings and the questionnaire responses. The SBE method is designed to normalize idiosyncratic response clustering. As one observer may tend to use only the 1-5 portion of the ratings scale and another may be inclined to use only the 5-10 portion, a rating of 5 may indicate both best-case and worst-case, depending upon the individual respondent's rating tendency. The normalizing procedure is designed to correct for these scaling differences, thus providing an estimate of perceived scenic quality (or recreational acceptability) independent of observer judgmental criteria. A more complete discussion of the SBE method can be found in Daniel and Boster (1976).

Analysis of variance for both scenic quality and recreational acceptability ratings were run on the raw-score data. These analyses centered on the effects that fire type, recovery time, information treatment, order of presentation (scenic first or recreation first), and interaction effects among these variables exerted on ratings of scenes.

Two analyses of variance were run on the raw-score questionnaire data: one covering the fire-knowledge questions and one on the fire-attitude questions. These analyses centered on the effects exerted by information treatment, and question variation, as well as interaction effects.

Analysis of population sampling bias was done through correlation of the Cortner et al. questionnaire responses with those obtained from the "no information treatment" group in the present survey.

Summary

The research project, thus, was designed to investigate the following questions:

- What are the public's perceptions of scenic quality and recreational acceptability of ponderosa pine forest areas that show the effects of both light and severe intensity fire, and how do these perceptions change with forest recovery over time?
- Is recreational acceptability assessment essentially equivalent to scenic quality assessment?
- What are the effects, if any, of increased knowledge of fire impacts on these perceptions?
- How effective are production functions for communicating fire-effects in ponderosa forests to the general public? How effective are line drawings for this purpose?
- What is the relationship between fire-effects knowledge and tolerance of fire in ponderosa pine forests by the general public?
- Does the convenience sampling technique employed introduce a fire-knowledge or fire-attitude bias?
- Does evaluating scenic quality bias a subsequent evaluation of recreational acceptability and vice-versa?

CHAPTER IV

RESULTS

This chapter presents the results of the present experiment in two general categories: first, the perception testing results; and second, the results of the post-test questionnaire.

Perception Testing

Perception results deal with the nuisance variable -- order of rating effects -- first. Scenic evalution results are treated second, recreational evaluation third, then a comparison of scenic and recreation evaluations leading to some considerations of the interaction between perception and recreation types.

Order Effects

To be able to make direct comparisons between scenic and recreational evaluations, it was felt that having the same observers rate scenes for both scenic quality and recreational acceptability would yield the most reliable results. Since it was unknown whether rating one of these dimensions would bias a subsequent rating of the other dimension, half of the observer groups rated scenic quality first and recreational acceptability second, the other half rated scenes in the reverse order. The results were then analyzed for order effect.

The effect on perceptual rating of scenic quality of the subject's having just completed a recreational acceptability rating exercise, and vice versa, were subjected to analysis of variance. The calculated variance for order-effect within scenic quality ratings and within recreational acceptability ratings is not significant at the .05 level. This finding is visually substantiated by Figure 2 which shows SBE values for scenic quality and RAE values for recreational acceptability aggregated across treatment, observers, and slides; separated by order of rating.

Scenic Beauty Evaluation

Evaluation of the scenic quality ratings was done through SBE analysis as well as analysis of variance (ANOVA) of the 10-point raw ratings. Figure 3 shows the scenic beauty estimations (SBE's) aggregated across all information treatments for both light and severe fire over recovery times. Also shown in this figure, for comparative purposes, are the SBE's obtained from the expert group. Both the general public and the expert samples show clearly distinct scenic evaluations for light-fire and severe-fire effects in ponderosa pine forests. This finding is substantiated by the ANOVA results which show a main effect of fire-type, $F_{(1/20)} = 596.85$, $p < .01$.

The effects of recovery time upon perceived scenic quality also are clearly separated by fire type. Light-fire effects seem to improve scenic quality for the first two or three years, with indications of a subsequent decline back toward control, no-fire conditions. Severe fire effects on ponderosa pine forests show a substantial decline in perceived

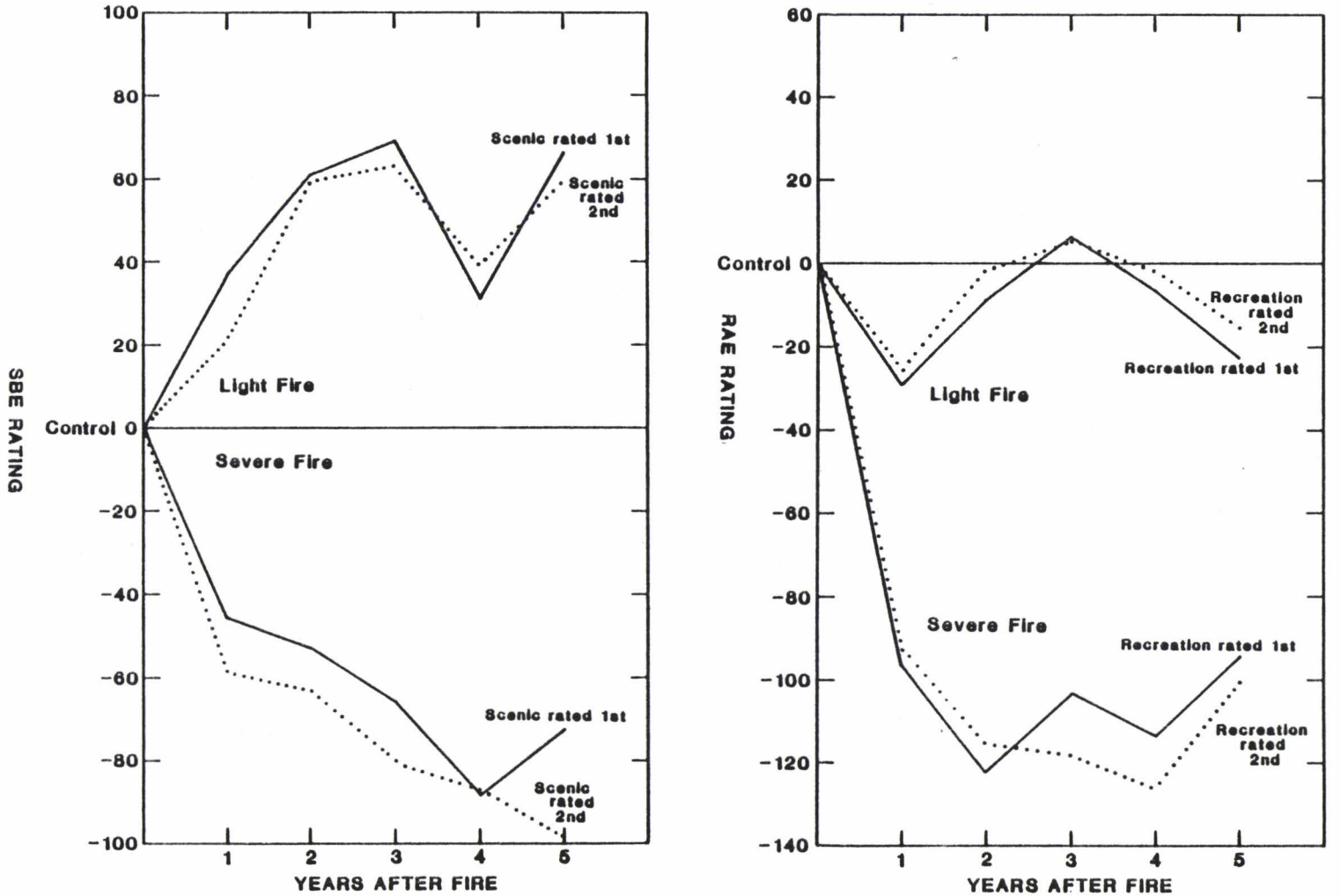


Figure 2. Order of Rating Effects

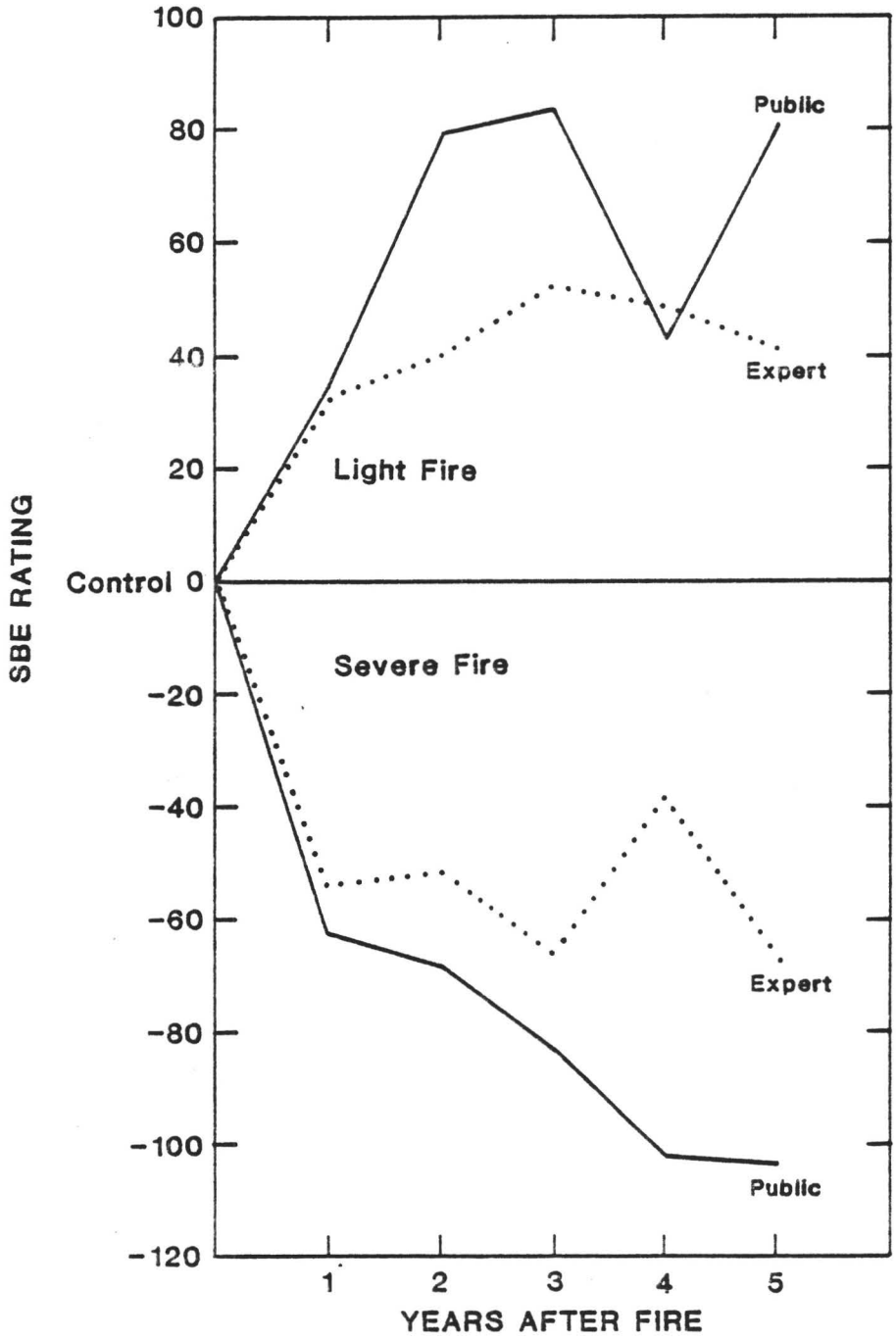


Figure 3. SBE's for the General Public (Aggregated) and Expert Samples

scenic quality, tending to level off during the last one or two years of the five-year period tested. These observations are corroborated by the ANOVA results which show the recovery-time main effect to be significant, $F_{(4/480)} = 16.19$, $p < .01$. As could be anticipated, the fire type-by-recovery interaction effect is also significant, $F_{(4/480)} = 36.43$, $p < .01$. It should also be noted from Figure 3 that the expert sample tends to deviate less from the no-fire control level for both light and severe fire scenic effects than does the general public sample. This will be discussed more in the section dealing with information treatment effects.

The effects of information treatments upon perceived scenic quality are not significant. The series of graphs in Figure 4 show SBE's for each information treatment group. Each graph shows light fire and severe fire SBE's separately. Order-of-presentation is also displayed separately within each information treatment graph. The control - information graph also includes the "no information" group SBE's (dashed line) which had only one order of presentation.

One can see, from scanning Figure 4, that the SBE patterns are quite similar across information treatments. The light-fire inverted U and the severe-fire continuous decline are still evident. Close examination of Figure 4 shows a slight tendency toward less deviation from the no-fire control condition as one proceeds from no information through control, production function, full information, to line drawing information treatment; a slight "closing of the mouth," as it were, toward the pattern exhibited by the expert group in Figure 3. The information

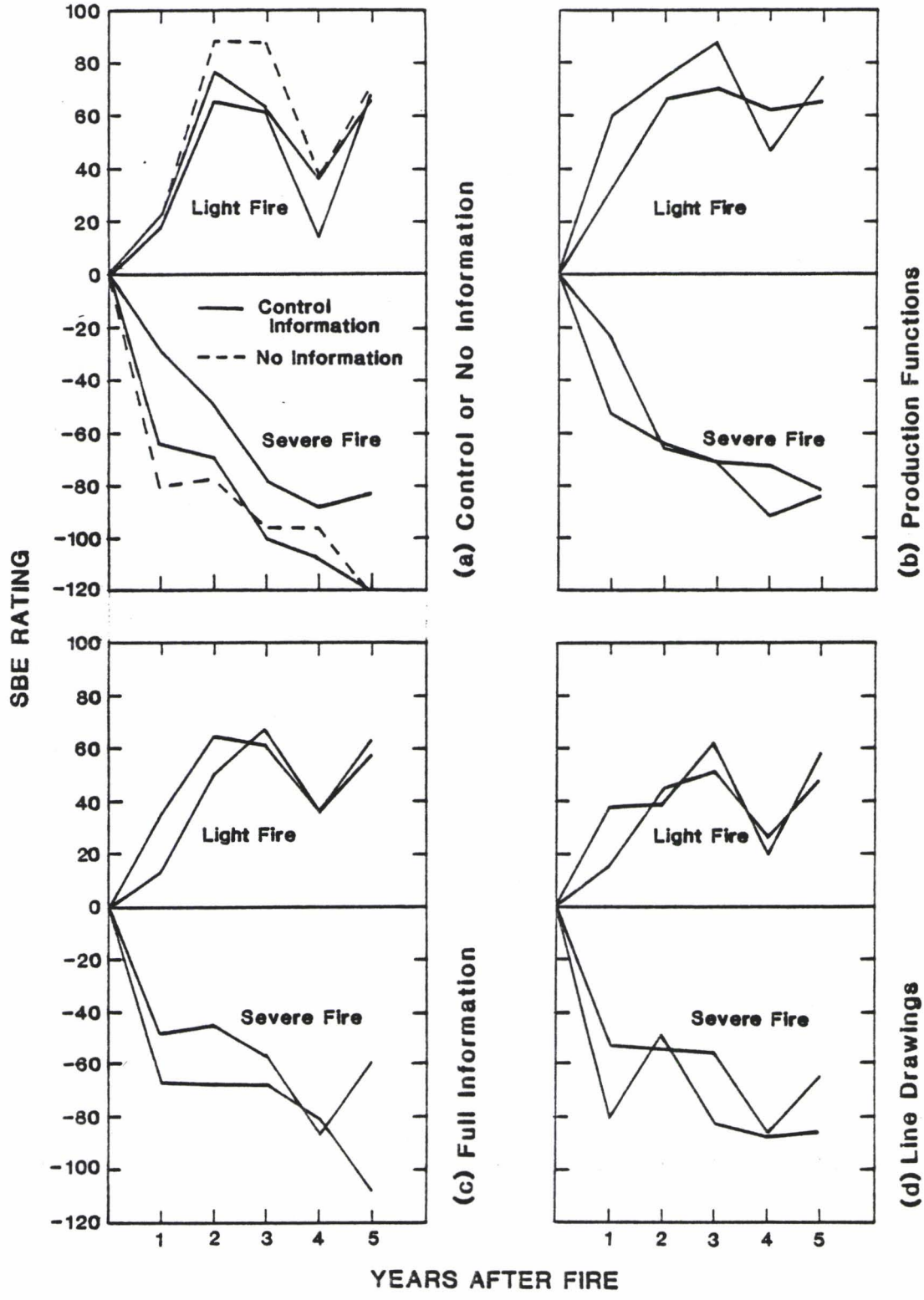


Figure 4. SBE's Aggregated by Information Treatment

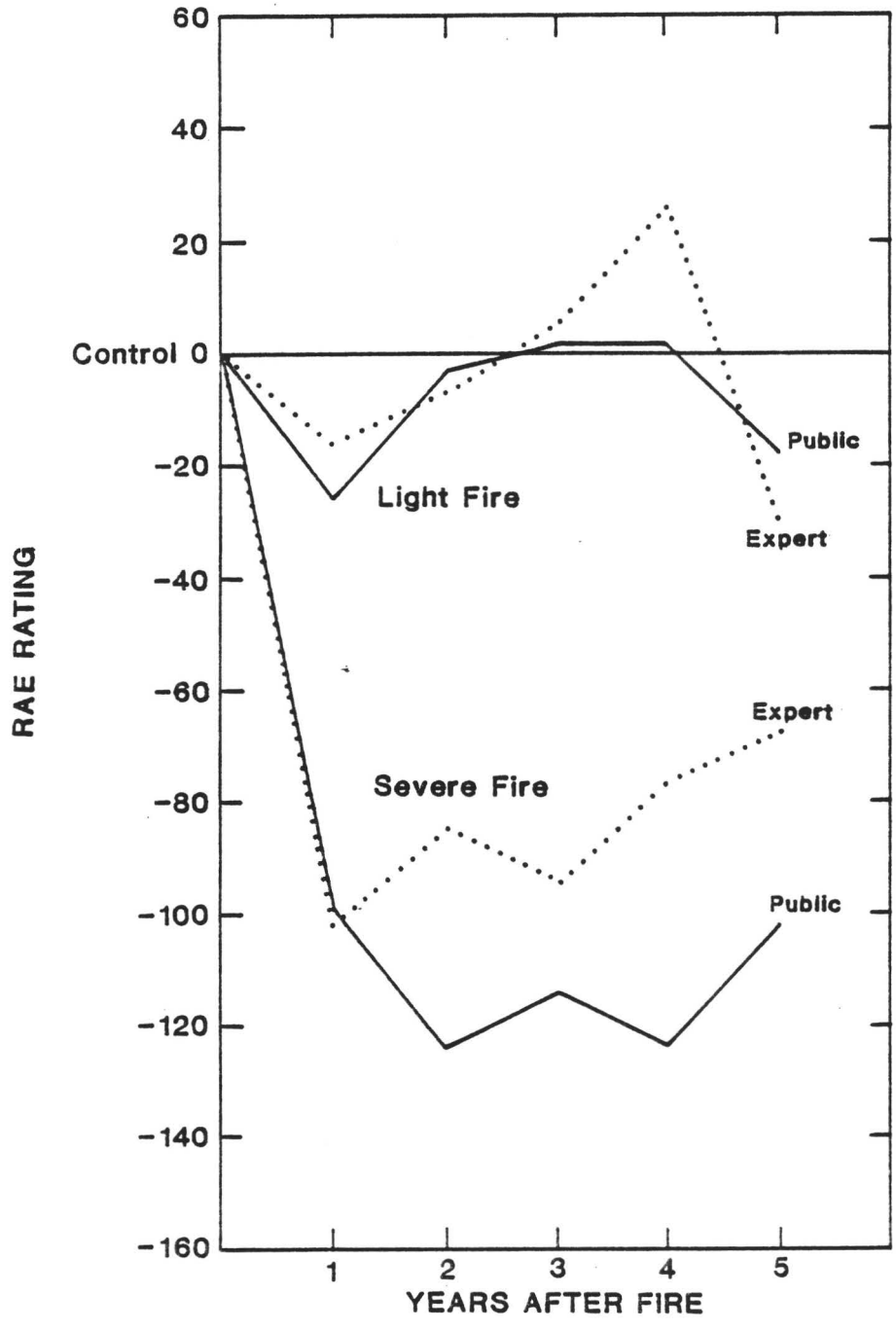


Figure 5. RAE's for the General Public (Aggregated) and Expert Samples

treatment-by-fire type-by-recovery time interaction is significant at the .05 level, $F_{(12/480)} = 2.01$, but not at the .01 level used throughout these analyses. This suggests that some slight information treatment effect may be operative, but treatment shifts in SBE magnitude are small compared to those contributed by fire effect, recovery time, or fire-by-recovery interaction. The information treatment-by-fire type interaction is not significant.

Recreational Acceptability Evaluation

Recreational acceptability ratings also were evaluated through application of an SBE-type analysis as well as analysis of variance of the raw scores. Figure 5 shows the recreation acceptability estimates (RAE's) over time, aggregated across all information treatments and across all recreation choices, for both light and severe fire. Also shown here, for comparison, are the RAE's obtained from the expert group. Both population samples show clearly distinct recreational acceptability evaluations for light-fire and severe-fire effects in ponderosa pine forests. This finding is substantiated by the analysis of variance results which show a main effect of fire type, $F_{(1/120)} = 404.88$, $p < .01$. It should be pointed out here that the RAE results are generalized over the different kinds of outdoor recreation selected by respondents.

The effects of recovery time on perceived recreational acceptability also are clearly separated by fire type. Light fire effects again exhibit an inverted U pattern, starting below then rising to or slightly above the control, no-fire level for years 2, 3 and 4, then dropping back to year-one levels by the fifth year following the fire.

Severe fire effects show a significant decline in recreational acceptability, but with more apparent leveling off in the later years than was true of scenic quality evaluations. Analysis of variance corroborates these results: the effect supplied by the fire type-by-recovery time interaction is significant at the .01 level, $F_{(4/480)} = 25.27$. Recovery by itself, however, does not explain a significant portion of the variance in recreational evaluation.

The effects of information treatments upon recreational evaluation are not significant, neither as simple effects nor interaction effects. The series of graphs in Figure 6 show RAE's for each information treatment group. Each graph shows light fire and severe fire RAE's, as well as order of presentation, separately. The control-information graph also includes the "no information" group RAE's, which again had only one order of presentation.

As with the SBE's, RAE patterns are quite similar from one information treatment to the next. Light fire again shows an inverted U pattern, while severe fire - after an initial rapid decline - tends to level off. Whereas the expert group tended to show less overall deviation between light and severe fire recreational acceptability, there is no apparent tendency for information treatment groups to move toward the expert recreational acceptability estimates. Thus, the provision of fire effect information does not seem to significantly change persons' evaluations of how good a burned ponderosa forest area might be for outdoor recreation.

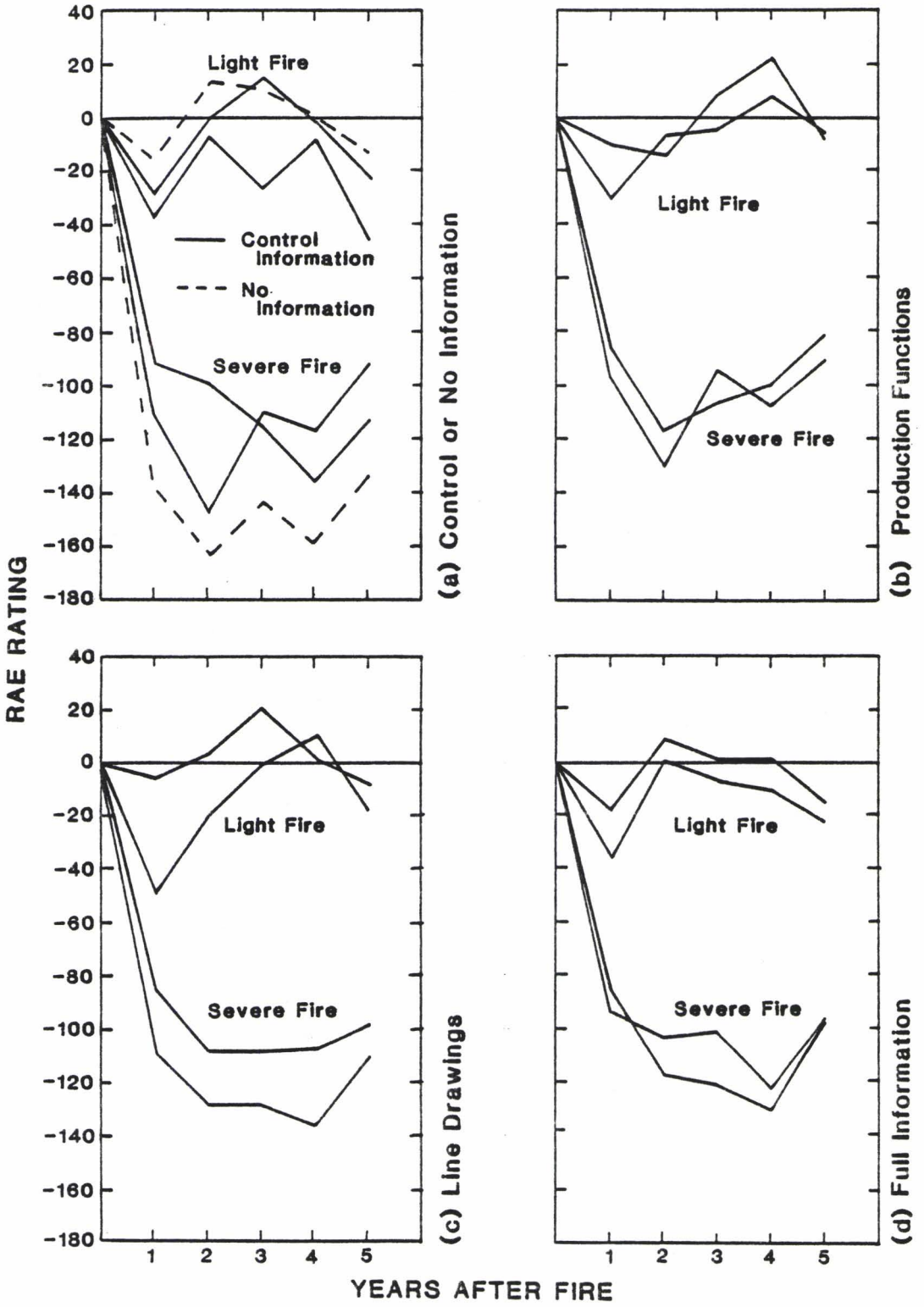


Figure 6. RAE's Aggregated by Information Treatment

Comparison of Scenic and Recreation Evaluations

Comparison of results presented earlier in this chapter suggest that evaluations of ponderosa pine forest burn areas for scenic beauty and for recreational acceptability may indeed yield somewhat different results. For example, comparing the aggregated SBE's shown in Figure 3 with the aggregated RAE's shown in Figure 5 indicates two general differences in these data sets: First, scenic evaluation by the general public seems to show a greater discrimination between severe and light fire than does evaluation of recreational acceptability. The range of difference between SBE's is 186 and the average difference is 148, while the range of difference between RAE's is 126 with an average difference of 104. Secondly, the positioning of light-fire and severe-fire evaluations relative to the no-fire control level is markedly different between Figures 3 and 5. All light-fire scenic evaluations are above the control level, ranging as high as 83, while 3 of the 5 recreation light-fire evaluations fall below control, ranging only as high as 2. Scenic severe-fire evaluations reach a minimum low of -103, but recreation severe-fire evaluations reach -124. This second phenomenon could be explained by a shift in control levels, especially considering that the control base-line for each slide set was established using only four slides each.

An experimental cross check was conducted to determine how much of these perceptual response pattern differences might be merely an artifact of slide-set variation. For this run, the scenic slide set was rated for recreational acceptability and vice-versa. All eight control slides were included in both evaluations to allow cross checking of

control levels, i.e.: 48 slides were rated each time. In this "reverse evaluation", the SBE rating for the scenic set control slides is +2, that is, when rating the recreation slide set for scenic beauty, the scenic set control slides are rated two points higher than the recreation set control slides. However, when the scenic slide set is rated for recreational acceptability, the recreation set control condition is rated 30 points higher than the scenic set's own control. A shift of control levels in the range of 2 to 30 points could more closely align the severe-fire evaluations of Figures 3 and 5, but would still leave at least a 50-point differentiation between scenic and recreational evaluations of light-fire areas. Thus differences between Scenic Beauty Estimations and Recreational Acceptability Estimations cannot be explained solely as differences between controls.

The reverse run group was organized to correspond with one of the information treatment groups, thus all participants reviewed the "control information" packets, and order was scenic quality evaluation first and recreational acceptability second. The comparisons between the reverse run and the appropriate control information group are shown in Figure 7. Here, the scenic and recreational judgments are compared for each of the two slide sets. The scenic and recreational evaluations of the recreation slide set (Figure 7-b) show little discrimination between the two classes of judgement. These two evaluations of severe fire areas are virtually indistinguishable, and for light fire areas, recreation and scenic evaluations are close, although the latter averages somewhat higher.

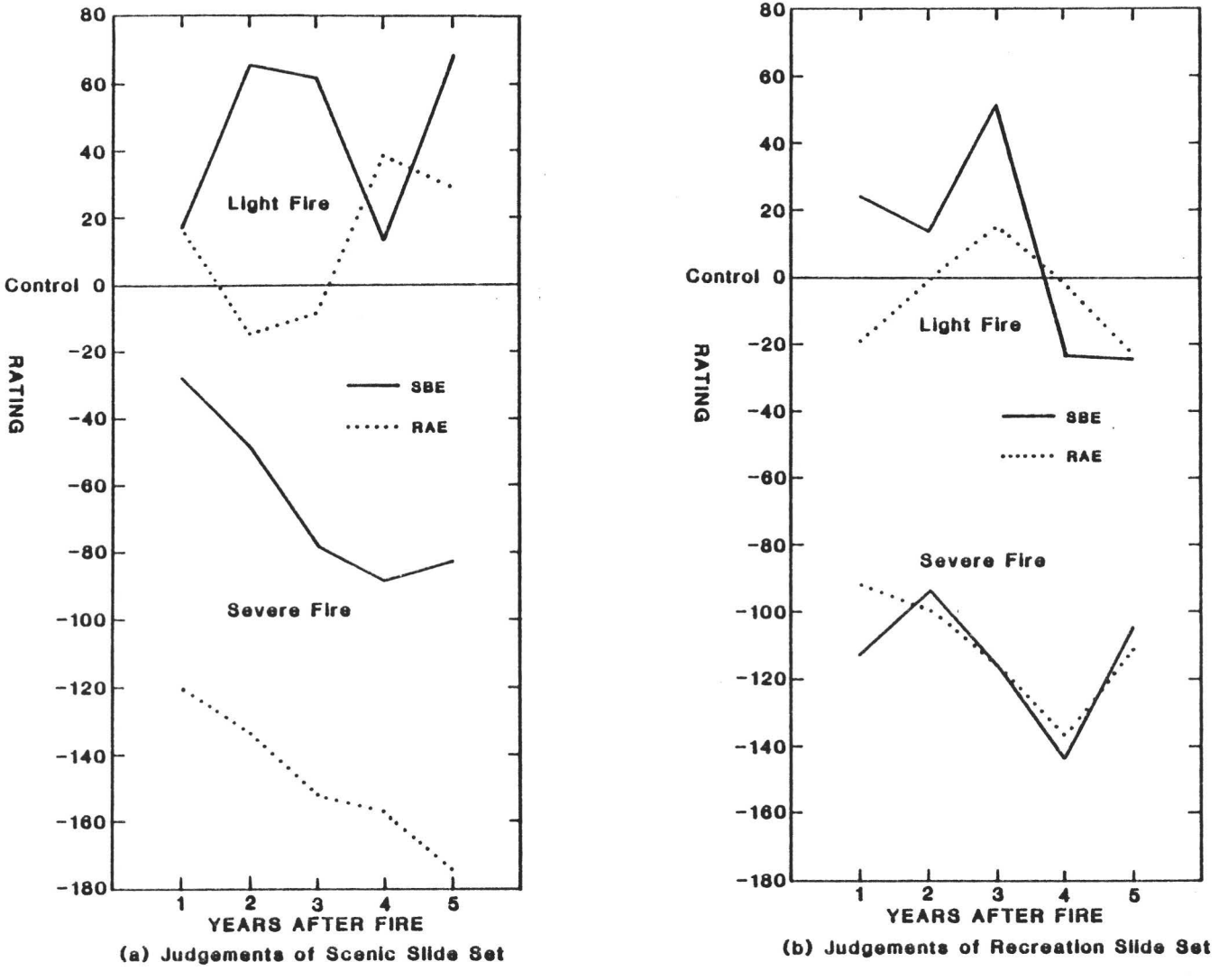


Figure 7. Comparison of Reverse and Standard SBE and RAE Evaluations by Slide Set.

The scenic and recreational judgements of the scenic slide set, however, show distinct differences between classes of judgement. Scenic evaluation of light fire areas stays consistently above control levels while recreation evaluation dips slightly below control. For severe fire areas, scenic judgements of this slide set run some 70 to 90 points above recreation judgements. Adjusting for differences between the two controls would tend to merge light fire evaluations, but severe fire recreation judgements would remain 40 to 60 points below scenic judgements. This would indicate that some kind of interaction effect might be affecting the relationships among fire types, recovery times, slide sets, and evaluation dimensions.

To test the effects these parameters were exerting on the slide set - evaluation dimension cross check, an analysis of variance was run on the raw scores in the comparison among groups displayed in Figure 7. No significance is attributable to slide set or evaluation type main effects, nor to slide set-by-evaluation dimension interaction effects. Lack of a significant evaluation dimension effect would suggest that evaluations for scenic quality and recreational acceptability are relatively indistinguishable. Fire type contributes the greatest main effect ($F_{(1/160)} = 645.23$, $p < .01$); fire-by-recovery interaction also contributes significant effect ($F_{(4/240)} = 12.20$, $p < .01$); and recovery time main effect also is significant ($F_{(4/240)} = 4.07$, $p < .01$), although of lesser magnitude than fire or fire-by-recovery interaction. This same pattern is evidenced in the scenic evaluation ANOVA reported earlier. However, the four-way interaction, fire-by-recovery-by-slide set-by-

evaluation dimension does show a significant interaction effect, ($F_{(4/240)} = 5.02$, $p < .01$).

The four-way interaction among fire type, recovery time, slide set and evaluation type is visually apparent in Figure 7, but difficult to interpret. The two groups contributing evaluations to these analyses, therefore, were more closely scrutinized to determine if some group idiosyncracy might be responsible in part for these variances. Since information treatments were the same for the two groups, the recreation activities selected were tallied. The results of this tally (see Table 7) show quite different patterns in selection of recreational activity between these two cross check groups. This, in turn, raises the question of how the specific recreation activity selected affects recreation acceptability evaluations. RAE's were, therefore, aggregated by recreation activity.

TABLE 7

RECREATION ACTIVITIES SELECTED BY THE CROSS COMPARISON GROUPS
(by percent)

	Driving for Pleasure	Picnicking	Nature Study	Hiking or Back Packing	Camping	Hunting	ORV Use
RAE of Scenic Slides	0	38%	6%	13%	44%	0	0
RAE of Recreation Slides	6%	6%	25%	38%	19%	6%	0

Quite different RAE patterns are obtained when subjects are combined according to the outdoor recreation type selected. Figure 8 shows obtained RAE values aggregated by Nature Study (n = 14), Hiking or Back Packing (n = 59), Picnicking (n = 36), and Camping (n = 31). Again, severe-fire and light-fire responses are graphed separately over recovery years. There do not appear to be particularly profound differences among nature study, hiking and picnicking evaluations for light-fire areas. All generally exhibit the inverted U curve, as does camping evaluation of light-fire areas, although the latter rating is somewhat depressed below the other three. Off-road Vehicle Use, Hunting, and Driving for Pleasure were selected by too few respondents to allow meaningful RAE evaluations (n = 3, 5, and 4, respectively).

Evaluation of severe-fire areas for recreational acceptability shows clear differentiation by recreation type. Camping is most sensitive to fire effects, both from light fire and severe fire. Picnicking is second-most sensitive to severe fire effects, hiking and back-packing third, and nature study least. Thus, a continuum of acceptability for fire-effected areas can be constructed across recreation types. A similar general order is suggested for responses to light fire, although without as much apparent separation.

To determine whether this differentiation in RAE by recreation activity might have been affected by disproportionate distributions of information treatments, a chi-square contingency analysis was conducted on an information treatment by recreation activity matrix. The chi-square value obtained (20.95 with 15 degrees of freedom) was not

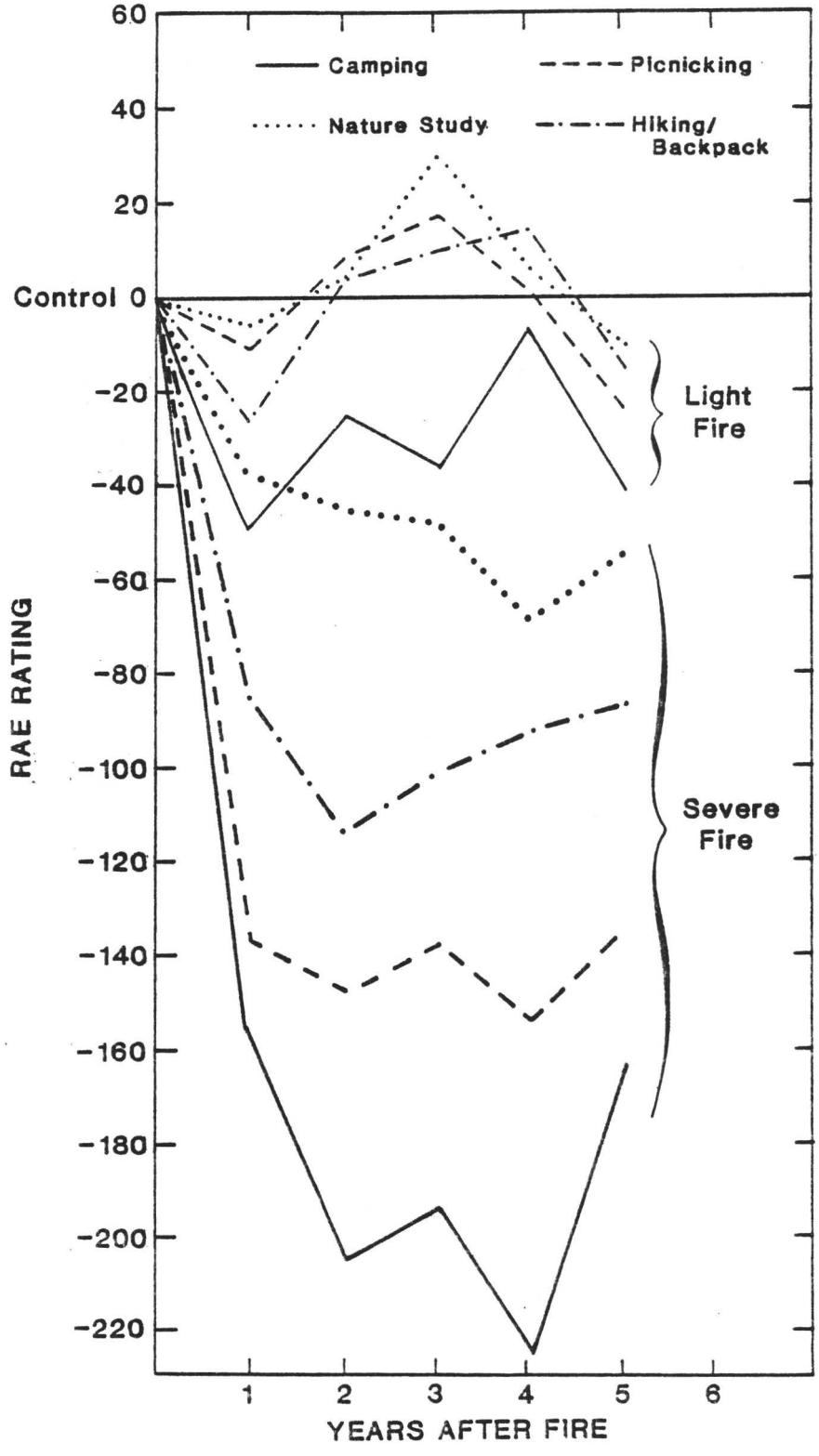


Figure 8. RAE's Aggregated by Recreation Activity

significant at the .05 level, thus no effect by information treatment on recreation activity selected was determined.

Referring back to Figure 7 and Table 7, it is important to note that over 80 percent of the respondents evaluating the scenic slide set for recreational acceptability had camping and picknicking as their references, the two most fire sensitive recreation activities tested. Conversely, of the control information group evaluating the recreational acceptability of the recreation slide set, 38 percent selected hiking or backpacking - the recreation activity most closely aligned with scenic judgement - and 50% were evenly divided between the least fire-sensitive activity (nature study) and the most fire-sensitive activities (camping and picnicking). Thus it is reasonable to expect, respectively, a wide separation in Figure 7-a and a close correspondence in Figure 7-b between SBE and RAE values for severe fire areas.

These recreational acceptability results, clearly distinguished by recreational activity, have several implications. First among these is that errors in perceptual evaluation could easily be made if close attention were not paid to how groups are combined. Secondly, a broad area of future recreation perception research is suggested, not just in fire affected forest areas, but in a broad range of recreation environments.

Questionnaire Results

Results from the post-test questionnaire are separated into four sections. The first section deals with the separate test designed to determine convenience sampling bias. Responses to fire knowledge

questions are considered second, to fire attitude third, and finally the relationship between knowledge of and attitudes toward fire in ponderosa forests.

Sample Bias Test

The questionnaire used in this survey was designed to test respondents' knowledge and attitudes toward fire in ponderosa pine forests. It contained ten fire-knowledge questions, seven elicited relative-effect quantitative responses (Severe - to - not at all) and three required a qualitative choice (see Appendix A). Six fire-attitude questions were included in the questionnaire: five quantitative and one qualitative response question.

A "no-information" subsample was drawn, wherein filling out the questionnaire was the first activity undertaken. This group's results were used for correlation with the same questions in the Cortner et al. telephone survey, to check for any inherent bias that might occur through use of the convenience sampling technique. A correlation coefficient was calculated between the mean-responses to the 12 quantitative response questions (7 fire-knowledge, 5 fire-attitude). This calculation shows a high correlation in response (r_{xy} = .96, $p < .01$) between the randomly selected telephone survey audience and the no-information treatment, convenience sample - in this instance, a church group. The bar graph shown in Figure 9 compares the four qualitative-response questions. As can be seen from this graph, the correspondence remains quite close.

Thus, no convenience-sample bias is found for this survey. These results do not categorically validate the use of paid respondents drawn

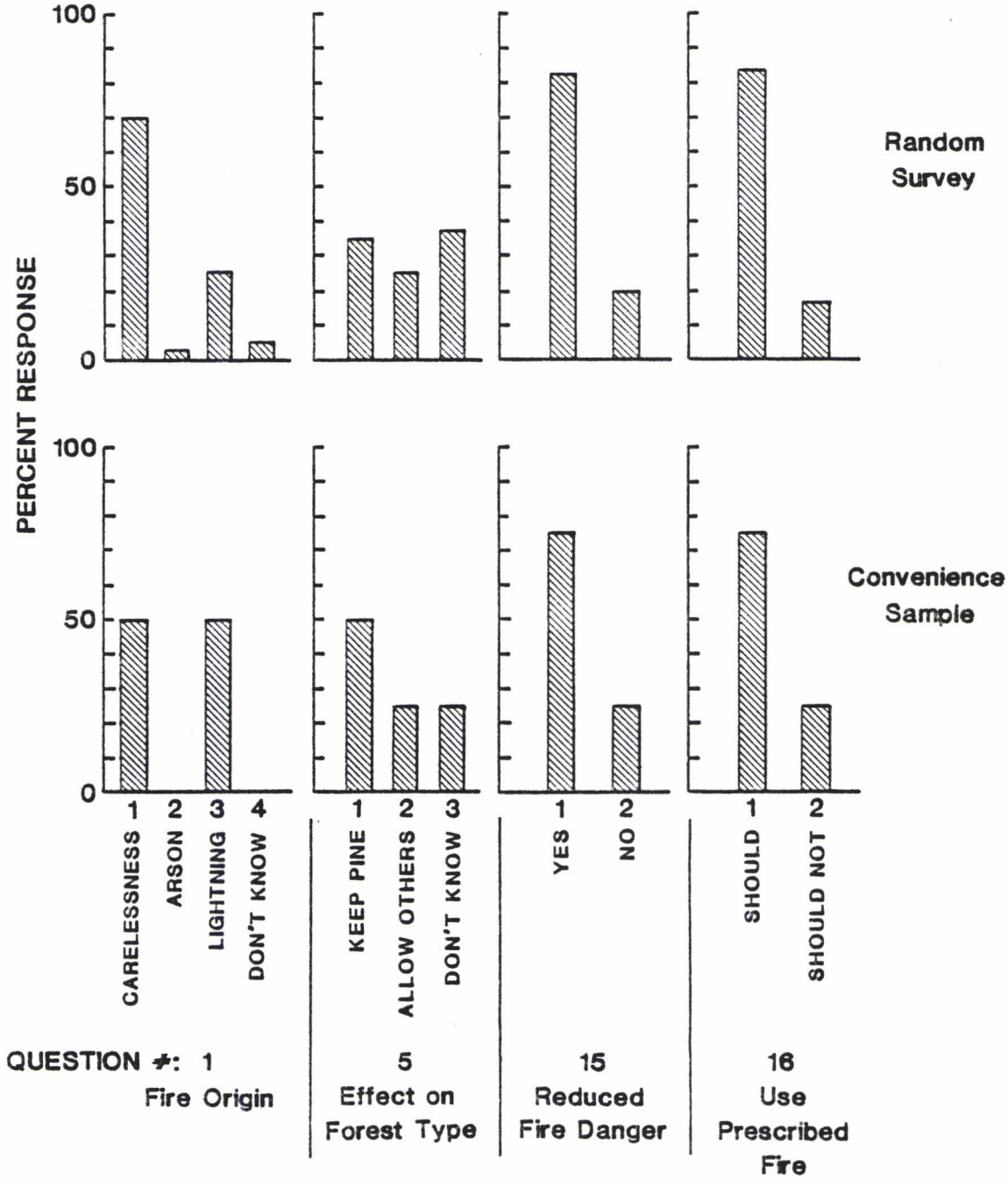


Figure 9. Comparison of Qualitative-Response Questions: Random Survey and Convenience Sample

from groups with no stated position regarding the issue being surveyed. However, they do add to a growing body of evidence that this sampling technique can yield an unbiased general public sample if carefully applied.

The final question of the short-form questionnaire was included to check for significant overlap in people drawn in the two survey samples: "Finally, have you been telephone interviewed within the past month about fire in pine forests?" Three persons, of the 158 utilized for the following data analyses, were included in both survey samples.

Fire Knowledge Responses

The overall purpose of the questionnaire was to test the effectiveness of the alternate information treatments in terms of changing knowledge and/or attitudes concerning fire in ponderosa pine forests. The fire-knowledge questions dealt with both direct and implied information from the fire-information treatments. Direct information was provided concerning: fire intensity; fire danger reduction; forest-type (or ecosystem) response to light fire; vegetative recovery; effects on wildlife; water pollution; soil erosion; and air pollution - in that order. What causes most ponderosa forest fires, and relative area burned could be inferred from the discussion. Of these categories, changes in knowledge regarding: forest-type response; fire intensity; fire area; and effects on wildlife are evident - three direct and one inferred, but not in the other six categories.

Figure 10 compares the average responses to the quantitative, fire-knowledge questions, aggregated by information treatment and

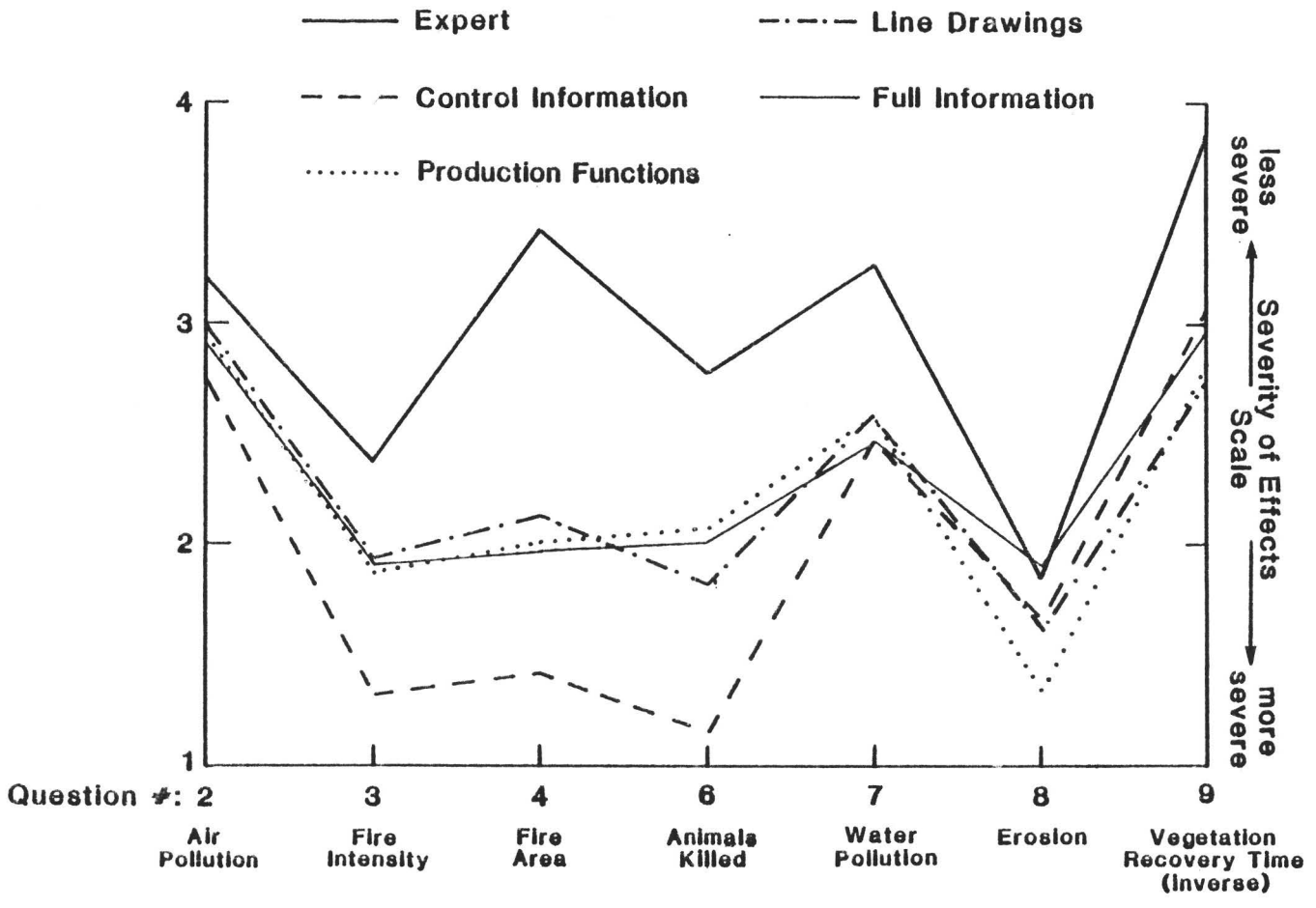


Figure 10. Fire Knowledge Responses: By Information Treatment Average

including expert responses for comparison. The inverse of question 9 is graphed to maintain consistent "direction" of response such that "1" implies major effects and "4" implies no or very little effect. (It should also be noted that question three concerning fire intensity, had only three response categories.) As can be seen from Figure 10, all three fire-information treatments tend to move fire-knowledge somewhat away from the "control information" levels toward "expert information" levels. This is slightly evident for air pollution knowledge; quite clear for fire intensity, fire area, and animals killed; but not true for the other three questions. In the case of erosion effects, the public was generally already in agreement with expert knowledge; in the cases of water pollution and vegetative recovery, the information treatments failed to change public knowledge.

Figure 11 compares the percent response by category for the three qualitative fire-knowledge questions. Here, knowledge about the effects of light fire on forest-type has been clearly influenced; reduced fire-danger was already known; but the usual origin of fires in ponderosa forests remains generally misunderstood.

These graphic indications that fire knowledge is partially affected by information treatment are substantiated by the analysis of variance of the quantitative-response questions concerning knowledge of fire effects: Information treatment $F_{(3/124)} = 7.27$, $p < .01$. However, since responses in some areas of explained fire effects remain unchanged while responses in other implied areas do change, the effect of the information treatments can best be described as a general "halo" effect.

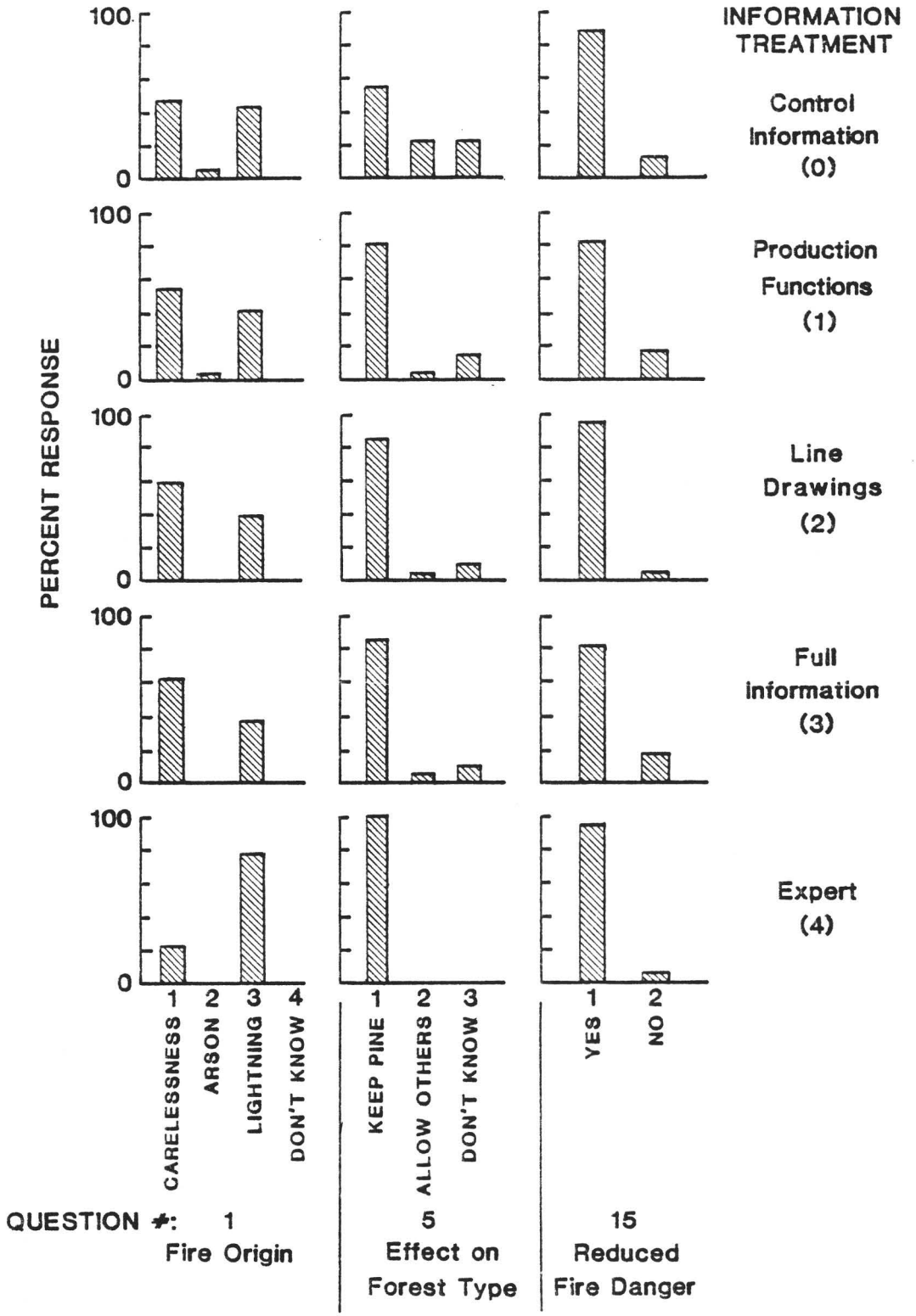


Figure 11. Responses to Qualitative Fire-Knowledge Questions

The direction of the generalized change is toward the expert position which views fire effects in ponderosa pine forests as less severe.

A significant interaction effect between questions (Q) and information treatment (T) emerged from the analysis of variance $F_{(17/744)} = 2.10$, $p < .01$. To determine where the source of significant interaction lay, a Tukey post-hoc paired comparison analysis was run on the Q x T means. The critical value obtained for the Tukey comparison, at the 95% confidence level (28/744) = 6.76. Comparison of mean responses by treatment within questions shows significant differences between the control-information group and the three fire-information groups at the 95 percent confidence level for question 6: "How many animals are killed by severe fire?" (Q6: $T_0\bar{X} - T_1\bar{X} = 9.38$; $T_0\bar{X} - T_3\bar{X} = 8.44$; $T_0\bar{X} - T_2\bar{X} = 6.88$). The line drawing information treatment is significantly different from control-information at the 95 percent confidence level for question 4: "How much area do most forest fires burn?" (Q4: $T_0\bar{X} - T_2\bar{X} = 7.19$). No other paired comparisons of mean responses by treatment within questions show significance at the 95 percent confidence level. From this data, no significant difference in effectiveness in imparting fire knowledge can be determined between production functions and line drawings.

Overall, then, the information treatments produce a generalized effect upon fire knowledge toward a realization that the effects of fire upon ponderosa pine forest are not so severe as one might assume. Added to this is a specific change in knowledge regarding the effects of fire upon fauna: that fewer animals are killed by forest fire than the uninformed would assume.

Fire Attitude Responses

The fire-attitude questions were designed to test respondents' relative tolerance for fire in ponderosa pine forests. Tolerances for different kinds of fire were tested, ranging from light-fire through fires that are already burning, lightning caused fire, to fires caused by human carelessness. Respondents were also asked whether they agreed or disagreed that no fires should be allowed to burn in pine forests and that forest managers should periodically burn underbrush and debris in these forests (prescribed burning). All of these fire attitude questions, except the latter concerning managers prescribed burning, were given as opinion statements to which respondents indicated their agreement on a four-point scale from: 1) strongly agree to 4) strongly disagree. The text and layout of these questions can be seen in the questionnaire included in Appendix A.

The responses to these questions, averaged by information treatment and including the average expert responses for comparison, are shown in Figure 12. For questions 10 through 13, agreement would indicate a more tolerant attitude towards fire in a ponderosa pine forest. Since question 14 suggests that no fires should be allowed in such forests, agreement would indicate a less fire-tolerant attitude. Therefore, the inverse of the question 14 response averages is plotted, i.e.: $5 - \bar{X}$. As can be seen from Figure 12, the expert group exhibits the most tolerant attitude toward fire, the control-information group the least tolerant attitude, with the fire-information treatment groups falling in-between. Light fires are generally tolerated, fires caused by human carelessness

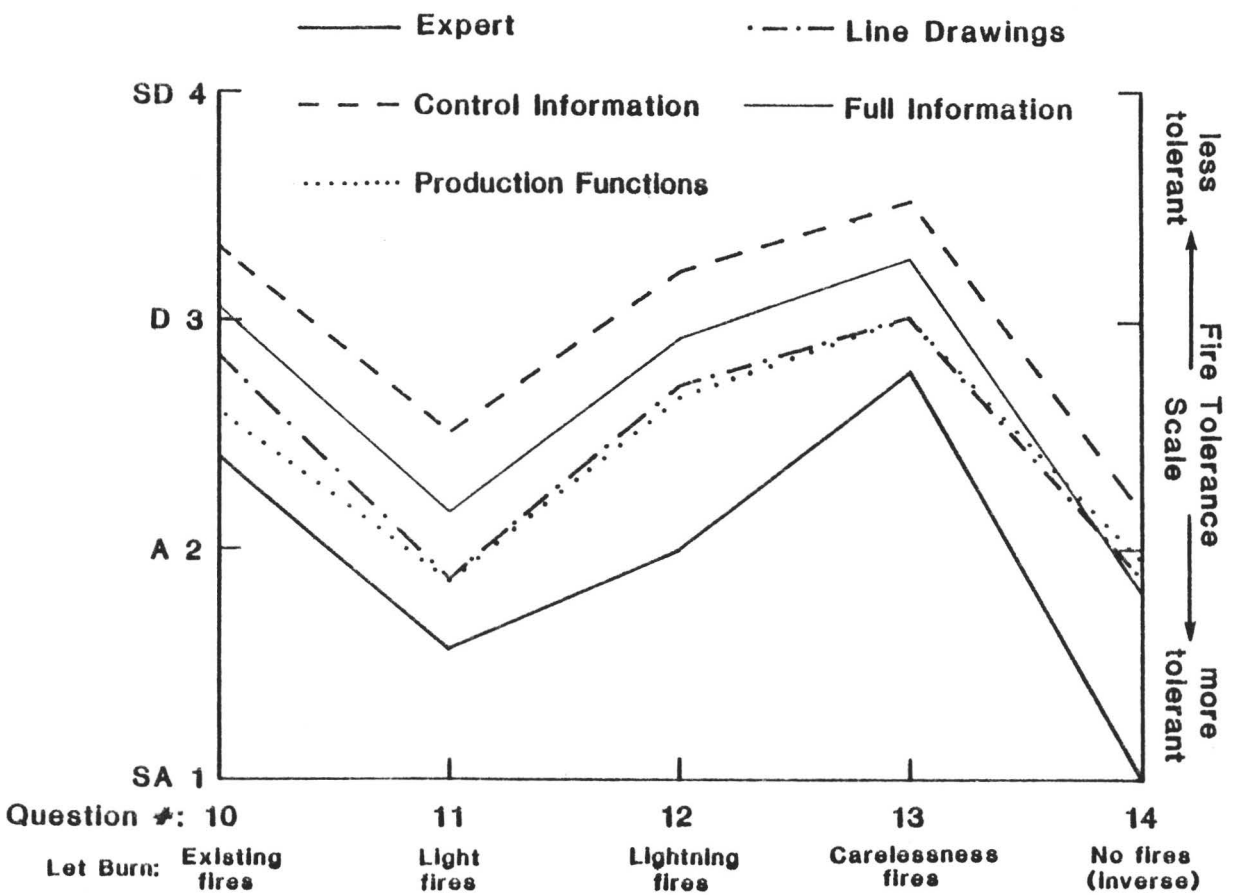


Figure 12. Fire Attitude Responses: By Information Treatment Average

definitely are not. Experts agree that lightning-caused fires should be allowed to burn while all four information-treatment groups disagree, although not so strongly as in the case of fires caused by human-carelessness. The "fires that are already burning" category generally falls between the tolerance levels for lightning-caused and carelessness-caused fires. This category is, perhaps, a bit ambiguous for it indicates neither origin nor intensity, but was intended to represent a logical opposite pole to the statement "No fires should be allowed to burn." The "no fire" statement is generally disagreed with by all groups, the expert group being most adamant ($\bar{X} = 4$, SD = 0.00).

That fire attitude is affected by information treatment is corroborated by analysis of variance of the quantitative-response fire attitude questions, information treatment $F_{(3/124)} = 7.60$, $p < .01$. The general effect of providing fire information is to increase people's tolerance of fire in ponderosa pine forests. The interaction effect between information treatment and questions is significant at the .05 level ($F_{(12/496)} = 1.93$) but not at the .01 level. A Tukey post-hoc paired comparison analysis of the Q x T means, however, shows significant difference only between the control-information and production-function, graph information group means for question 10: "Fires that are already burning should be allowed to burn as long as they're watched." The indication is that, again, a general "halo" effect is achieved on fire attitude. Production functions and line drawings are not shown to be significantly different in influencing attitudes toward fire in ponderosa forests.

Responses to the qualitative fire-attitude question, asking whether forest managers should (1) or should not (2) periodically burn underbrush and debris in pine forests, are shown in the first column of Figure 13. The percent response by categories for this question shows little difference among groups. Here, from 87 to 100 percent of the people surveyed agree that forest managers should use periodic prescribed fire. The lowest agreement to the use of prescribed fire found in the present research context was that elicited by the Cortner et al. telephone survey where respondents were given the option of stating, "I don't know." Cortner et al. found that over two-thirds of their respondents approve of prescribed burning and only 15 percent disapprove.

Two final questions were included to elicit an evalution of the information brochures. Responses to these questions are shown in columns two and three of Figure 13. Respondents were asked to rate their information brochures on a 1-to-10 scale of clarity, and if they would actually read such a brochure if received unsolicited in the mail. On a 1 to 10 scale from "incomprehensible" to "completely clear," the information brochures are given an overall average rating of 8.12. The control-information brochure, with the least information, receives the highest rating (8.25) while the full-information brochure receives the lowest rating (7.94 - see column 2, Figure 13).

Seventy-seven percent of the respondents indicate they would read such a brochure if received unsolicited in their mail (column 3), 23 percent indicate they would not. Again, the group with the least complicated information - control information - shows higher

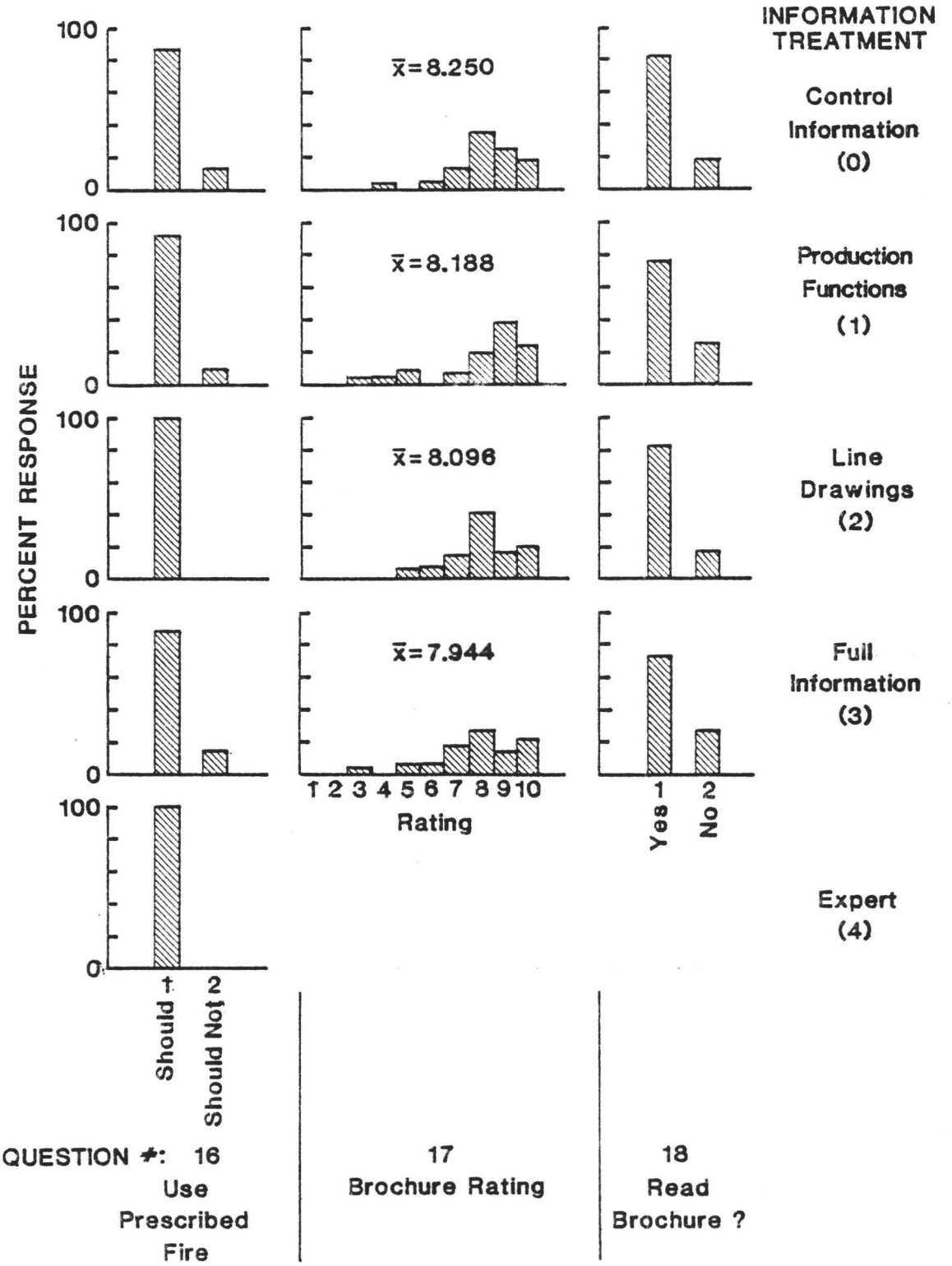


Figure 13. Acceptance of Prescribed Burning and of the Information Brochures

acceptability (81 percent would read through the brochure), while the more complex, more complete information treatment shows lower willingness to read through such materials, unsolicited (full information treatment: "yes" = 72 percent). These data are presented for general impression only, since the response situation was highly artificial for these particular questions: each respondent was contributing to his or her group's general economic welfare by participating in the experiment; and the author of the booklets was present at the time of evaluation. However, a general impression of brochure clarity and acceptability is evident.

Comparison of Fire Knowledge and Attitude

Stankey (1976), in his investigation of wilderness users' knowledge of and attitudes toward fire in wilderness areas, found that respondents' knowledge of fire effects served as a better predictor of fire attitude than did any other variable tested: age; number of visits; education. "Knowledge of the individual's test score explained nearly 60 percent of the variance in the selection of the 'most acceptable' statement" of fire suppression policy for wilderness areas. The post-test questionnaire for the present experiment was designed to allow comparisons with Stankey's results regarding both knowledge-attitude relationships and areas of low public knowledge.

Stankey compared the percent of correct test answers with a fire acceptability scale. In order to get comparable results, "correct" answers were determined for the post-test questionnaire, fire knowledge questions based on modal responses of the expert group (see Table 8). A

TABLE 8

"CORRECT" FIRE KNOWLEDGE RESPONSES:
BY MODAL RESPONSE OF EXPERTS

Question No.	Answer	Percent of Experts Agreeing
1	c) Lightning causes most forest fires.	71%
2	c) Forest fire smoke is a minor air pollution factor.	79%
3	b) Most ponderosa forest fires are moderately hot.	64%
4	d) Most forest fires burn less than 1 acre.	64%
5	a) Light fire will keep a ponderosa forest in pine.	100%
6	c) Few animals are killed by rapid, intense forest fires.	79%
7	c) Forest fires are a minor factor in water pollution.	57%
8	b) Moderate erosion results from intense forest fires.	57%
9	a) Vegetation will return within 1 year of an intense forest fire.	93%
15	a) Underbrush fires do reduce severe fire danger.	93%

percent correct score was calculated for each questionnaire respondent. A fire-attitude scale was also constructed for each respondent by means of summing the scores for questions 10-13 and the inverse of the question 14 answer. An additional point was added if answer "b" was chosen for question 16 (forest managers should not periodically burn underbrush and debris). The fire-attitude scale thus constructed ranged from 5 - complete fire tolerance, to 21 -complete fire intolerance. Comparison of the fire-knowledge scores (high = positive) with the fire attitude ratings (high = negative) should yield a negative correlation, if Stankey's findings were confirmed.

The expert sample group was excluded from this analysis in that their answers were used to determine the correct responses for fire-knowledge questions. A correlation analysis of the remaining 144 subjects' fire knowledge scores and fire attitude ratings yields a coefficient of $P_{xy} = -0.28$, $p < .01$. Figure 14 shows the plotted corelations between each subject's knowledge score and attitude rating. An inverse correlation is evident from both the test statistic and Figure 14, although not so strong a correlation as reported by Stankey. It is probable that provision of fire-effects information to 96 of these 144 subjects partially confounded the correlation between knowledge and attitude. Further, all but 16 of the subjects in the present experiment had just finished evaluating 88 scenes which they had been told showed evidence of different fire histories.

Stankey reported low scores on his fire effects questionnaire (average = 53 percent correct response), especially regarding areal

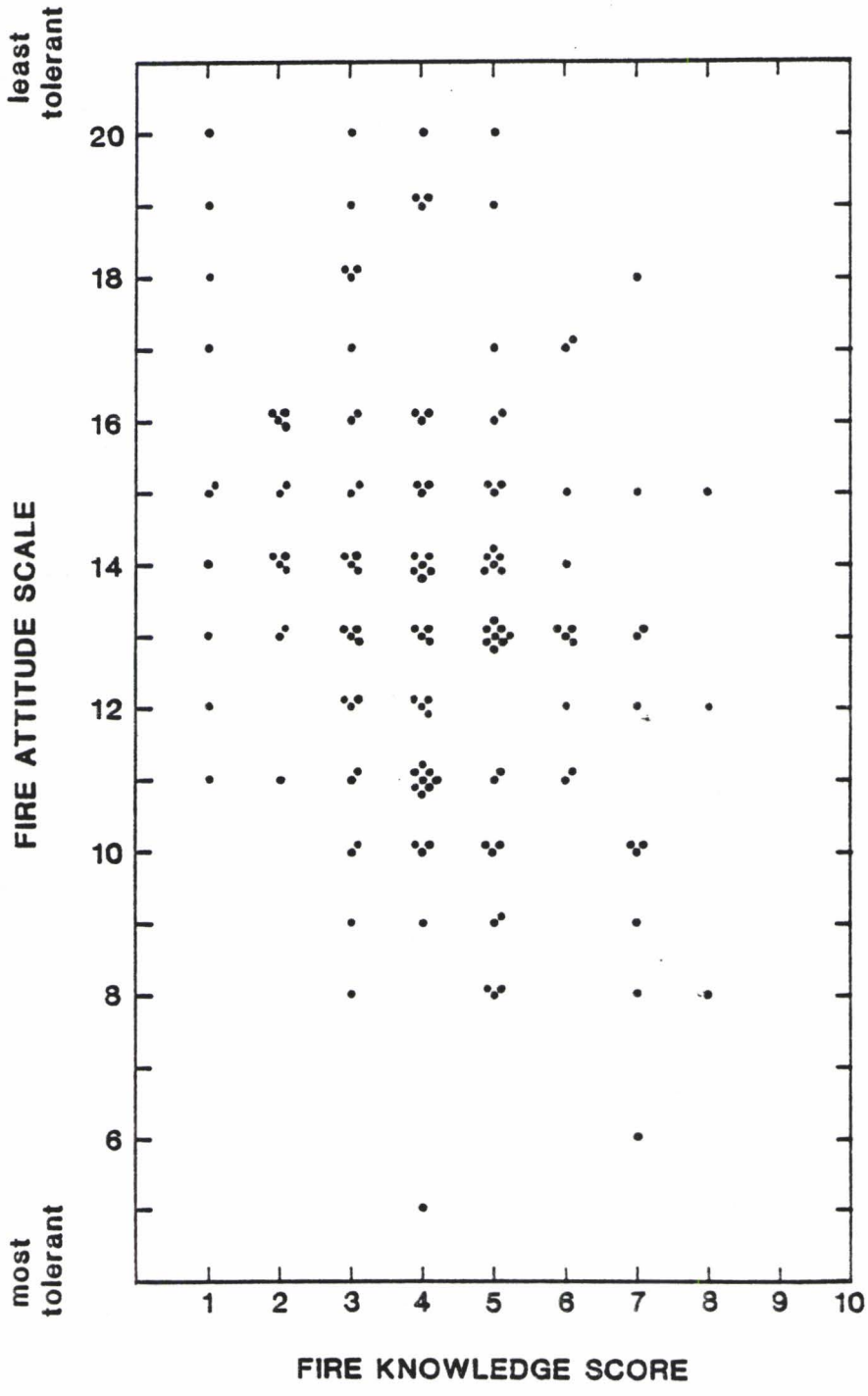


Figure 14. Correlation of Fire Knowledge and Attitude

extent of fires, the relation of fire hazard to fire suppression policy, the effects of suppression efforts on habitat, and animal death. Respondents in the present survey who did not receive specific fire-effects information (control information and no-information groups) also show low fire-effects knowledge (average = 38 percent correct response). Areas of lowest knowledge, in ascending order, are: vegetation recovery; ecosystem effects; areal extent of fire; the relation of light fire to hazard reduction; numbers of animals killed; and air pollution impacts. The two surveys did not use identical questions, format, nor numbers of questions, thus equivalent average test scores were not anticipated. The present research does corroborate Stankey's findings, however, that fire knowledge is rather low in the general public, and that public knowledge is specifically low regarding fire area, fire hazard reduction by light fire, vegetation-habitat-ecosystem effects, and animal death resulting from forest fire.

CHAPTER V

CONCLUSIONS

This chapter discusses methodological issues pertinent to the experimental design used in the present experiment, summarizes results according to the experimental questions raised at the end of Chapter III, and discusses the implications of these results. Finally, some suggestions are made concerning future research.

Methodological Issues

It is important at the outset to point out that the experimental design employed for this study was eclectic, a study in breadth intended to explore interrelationships among several factors -- fire type, information treatments, scenic quality, recreational acceptability, fire knowledge, fire attitude -- rather than an in-depth study of one or two specific parameters. The principal conclusions, thus, relate to interactions and relationships. Patterns are identified, but quantitative descriptions of the degree of change in these several parameters will depend upon follow-on research designed to explore single-factor changes.

The use of photographs as surrogates for real landscapes has been the subject of some controversy in the landscape perception literature. Gold (1980), Penning-Rowsell (1975), and Kreimer (1977) all question the validity of assumed correspondence of evaluations of photo

representations and real landscapes. Gold states his reservation to landscape preference testing based on visual qualities alone, certainly a valid criticism of the present study for no other ambience features of ponderosa forest environments (smell, sound, feel of wind) were present in the testing environments used. Evaluation through use of color slides represents a time and expense savings which allows such evaluative studies to be conducted; the costs of conducting some 150 respondents to 11 or more sites throughout Arizona would have been prohibitive. There is, however, a fair amount of empirical evidence that vision is used predominantly in the assessment of scenic quality. Daniel and Boster (1976), Rabinowitz and Coughlin (1970), Shafer and Richards (1974), Craik (1972), and Zube et al. (1974) have all demonstrated close correlations between scenic evaluations of slide stimuli and scenic evalutions made on-site.

A second problem, cited by Gold (1980), with the use of photos for landscape evaluations is the "selective view of the landscape," depending on the skills and motivations of the researcher. Random variation among photographs was controlled as much as possible through the use of one photographer, the same piece of equipment, the same specific kind of film, and the same processing laboratory for all the photographs taken for this experiment. Selective viewing was intentionally controlled by means of applying random compass headings for each set of photographs taken.

Arthur, Daniel and Boster (1977) raise the methodological issue that scenic quality assessment does not necessarily equal preference rating. This relates to Gold's (1980) third problem with the use of

photos; that the method does not account for situational factors, for example, what recreational activities the respondents might imagine themselves involved in. Arthur et al. (1977) cite evidence that scenic quality ratings "generally are higher than preference ratings, have smaller variance, and are more reliable." Zube et al. (1974) found systematic differences only when preferences were referred to some specific use. Arthur et al. conclude that differences between preference and quality ratings may be an artifact of the experimental method and instructions used. The present study makes a direct comparison between quality ratings (Scenic Beauty Estimations) and preference ratings (Recreation Acceptability Estimations) specifically keyed to some particular use --the choice of outdoor recreation. The scenic quality ratings were generally higher than the recreation acceptability ratings and variance much smaller for the scenic quality assessment, which findings support the first conclusions stated above. These differences, however, should not be considered as artifacts of the experimental method or instructions. The RAE experiment represents a direct adaptation of the SBE methodology, using parallel instructions.

The application of the SBE methodology to evaluation of recreational acceptability was experimental. The RAE results justify this application: respondents had no difficulty in judging scenes for recreational acceptability and did so consistently; recreational evaluations sort out clearly when distinguished by type of recreation activity selected. Interestingly, Arthur et al. (1977) state that "scenic beauty seems to be representable by a single evaluative

dimension; or, if several dimensions are involved, they are clearly mutually exclusive." Although recreational acceptability is not offered here as a reasonable surrogate for scenic beauty, when all types of recreation are aggregated, the resultant RAE's are only marginally distinguishable from SBE's. It is only when recreation choices are separated that RAE's are found to be distinct entities. These different dimensions (recreation choices) indeed appear to be mutually exclusive, or to balance out toward the more general dimension of scenic quality. But these findings do raise the question of what "situational factors," in Gold's terms, may be masked or hidden within aggregated evaluative dimensions.

Buhyoff and Riesenman (1979) have reported that factor-specific scenic quality evaluations are possible: subjects keying specifically on southern pine-beetle damage. Participants in the present experiment were informed that the scenes they were to evaluate showed a "variety of fire histories." Thus, a certain degree of keying on the visible fire effects is expected in the results reported here.

Gold (1980) states a fourth problem with the use of photographic representations in landscape evaluation: there may be order effects in the sequence of scenes evaluated. To control for order effects, a stratified random sample design was used: each stratum of 11 slides contained one view of each fire-recovery condition, but slides within strata were randomly selected and randomly ordered. The unavoidable "order" condition -- assessment of scenic quality first or of

recreational acceptability first -- was statistically tested and no order effect found.

Another methodological issue raised by Arthur et al. (1977) is that opinions elicited in surveys or evalutions may not reflect actual behavior. Heberlein (1973) states that "there is no clear linear relationship between single attitudes and behavior." This does not represent a serious problem for scenic beauty estimation, for in this instance the assessment is the behavior. The recreational acceptability testing, however, definitely raises the question of attitude/behavior relationships. In wilderness settings, for example, "artifactualists" (Heberlein, 1973) or "non-wilderness-purists" (Hendee and Catton, 1968) use wilderness more than do "non-artifactualists, wilderness purists." Hancock (1973) found that campers use areas more where 25% to 50% of the vegetative screening has been removed while simultaneously stating preference for heavier screening. Lucas (1966) determined that wilderness users "dislike crowding," but crowd never-the-less. Although social psychologists have found no direct relationship between attitude and behavior, motivation psychologists offer a qualified disagreement. Fishbein and Ajzen (1974) suggest that specific, intended behaviors correspond to actual behaviors provided they have known, expected and valued results. Driver (1976) uses this rationale to support his recreation experience-opportunity research.

In the present research on recreational acceptability of fire-affected ponderosa pine forest environments, respondents were asked to identify the specific form of outdoor recreation which they would most

enjoy in the forest environments depicted. Therefore, it is expected that the respondents were keying on projected behaviors which were known, expected and valued in their recreational acceptability assessments. Implications for forest managers of these research results are that some situational pressure of the experimental setting may be lending bias to the assessed attitudes and evaluations, and that some deviation between expressed attitude and subsequent behavior is to be expected. However, when population sample bias is controlled (or identified), field sampling bias is controlled, and survey wording is carefully constructed - the results should be expected to be much more reliable as operational bases for decision making than angry letters, on-site complaints or public hearings. Exploratory research projects such as the one reported here are involving the public in the decision and management processes.

Results and Implications

In the summary of Chapter III, several questions were raised which the present research was designed to investigate. The last two are essentially experimental method questions, and are the most simple to answer:

- Does the convenience sampling technique employed introduce a fire-knowledge or fire-attitude bias? The sample group drawn to test this question, those administered the questionnaire as the first activity, showed a .96 correlation coefficient with a general public, telephone survey using the same questions. No sample bias was detected.

- Does evaluating scenic quality bias a subsequent evaluation of recreational acceptability and vice-versa? Half of the respondents rated

scenic quality first and recreational acceptability second, the other half rated scenes in the reverse order. Analysis of variance of SBE's and RAE's obtained for these two "order of rating" groups showed no significant difference.

- What are the public's perceptions of scenic quality and recreational acceptability of ponderosa pine forest areas that show the effects of both light and severe intensity fire, and how do these perceptions change with forest recovery over time?

The clearest perceptual distinction made of the forest scenes evaluated, the factor accounting for the preponderance of variance for both scenic and recreational evaluations, is the differentiation by fire type. Light, or prescribed fire tends to moderately improve scenic quality for a 3-to-4 year period, which findings substantiate those reported by Anderson et al. (in press). By year 5, light-fire scenic quality trends appear to be returning to pre-fire conditions. Most probably, this scenic improvement relates to removal of undergrowth and debris, opening up the forest understory and allowing visual penetration to greater depths. By the fifth year, underbrush is beginning to recover. Severe fire clearly degrades scenic quality, and five years of recovery show no signs of scenic quality recovery. Severe fire changes the basic composition of the ecosystem from forest to an earlier grass and forb seral community. Succession, over the five-year period tested, tends to move from the grass and forb stage to a shrub and low deciduous tree community. Thus, not only is scenic quality initially severely impacted, there is some indication that it may continue to decline over the five-

year fire recovery period. Clearly, scrub communities are not nearly so scenically attractive as ponderosa pine forests. In each severe-fire area photographed, some timber salvage and clean-up operations had obviously been carried out. Had this not been the case, it is anticipated that scenic quality would have deteriorated even more than indicated by the results of this experiment. However, since salvage and clean-up are normal U.S. Forest Service and B.I.A. Forest Service activities following severe fires, the results reported here should more closely reflect usual post-fire conditions.

The public's perception of recreational acceptability of light and severe fire, ponderosa pine forest areas in general parallels scenic quality evaluation, but at a somewhat lower rating level. Light fire areas show the same general "inverted U" function as in scenic evaluation, but show less improvement over no-fire conditions for recreational acceptability. Again, severe fire clearly depresses recreational acceptability.

- Is recreational acceptability assessment essentially equivalent to scenic quality assessment? One of the more important findings of the present research project is that recreational acceptability of fire areas could be mistakenly deemed as essentially the same as scenic quality if the differences among recreation types were ignored. Differences between acceptabilities for separate recreation activities are greater than the difference between aggregated recreational acceptability and scenic beauty estimation, especially for severe fire areas. In light fire areas, acceptability for nature study,

picnicking and hiking-backpacking are not clearly differentiable, however, camping appears to be more sensitive to light-fire effects than the other recreation activities. Camping acceptability is dramatically depressed by severe fire effects, dropping nearly twice as low as SBE ratings. Picnicking acceptability also falls lower than severe fire SBE levels, hiking or backpacking is roughly equivalent to SBE ratings, and nature study is much less sensitive to severe fire effects than is scenic quality.

These results suggest that it is one thing to view or hike through a forest fire area, but it is quite something else to put down your tent or picnic basket in the midst of that ash or subsequent scrub growth. A few respondents volunteered explanations for their nature study evaluations: just because an area looks awful doesn't mean it's any less interesting for studying nature.

The management implications of these results for ponderosa forests are fairly clear. Prescribed light fires should tend to enhance scenic quality for 3 or 4 years; will probably have negligible effects on picnicking, hiking and nature study; but might have some adverse effect on camping. Severe forest fires should be expected to significantly deteriorate scenic quality and recreational acceptability (excepting nature study) for a prolonged time period; camping and picnicking are essentially precluded for these areas.

- What are the effects, if any, of increased knowledge of fire impacts on these perceptions? The fire-effects information treatments affected knowledge and attitude much more than they did perception of

scenic quality or recreational acceptability. Information treatment interaction with fire type and recovery time was significant at the .05 level for scenic quality evaluation, but not for recreational acceptability. In neither case were simple, information treatment effects significant. That provision of information should have some effect upon fire-knowledge and general tolerance for fire in forest areas, but not on perceptual evaluations, suggests that the relationship between perception and cognition needs to be considered in this context.

Ittelson (1973), in discussing perception of environments, states "the first level of response to the environment is affective. The direct emotional impact ... generally governs the directions taken by subsequent relations with the environment. It sets the motivational tone and delimits the kinds of experiences one expects and seeks." Zajonc (1980) offers a persuasive argument for the separation of thinking "discriminanda" and feeling "preferenda." Contemporary theory to the contrary, Zajonc shows empirical evidence that affective judgments may be fairly independent of, and precede in time cognitive processes generally assumed to be the basis for these preferenda. Preferenda include telling the good from the bad, the safe from the dangerous, the nice from the nasty, and occur more rapidly than cognitive processing would allow. Zajonc extends Paivio's "dual coding hypothesis," that picture processing is by right-brain hemisphere and word processing by left-brain hemisphere, to include processing of affect as "a more likely right-brain candidate" than processing of pictures. His evidence suggests that rather than affect being postcognitive, cognition may often by

postaffective: feeling often established first, and thinking arranged to justify the initial reaction.

These authors' conclusions suggest that the SBE and RAE evaluations of respondents in the present experiment are preferenda (good/bad judgments), performed rapidly (8 seconds maximum per slide judgment), and thus largely independent of discriminanda concerning the effects of fire on forest environments. This should be especially true in the present experimental situation where information had been obtained only a few minutes prior to beginning scene evaluations. Prolonged exposure to fire-effects information might be expected to have greater impact upon scenic quality or recreational acceptability perception of severe fire areas, but not necessarily. As Zajonc states, "Even the most convincing arguments on the merits of spinach won't reduce a child's aversion to this vegetable ... The dismal failure in achieving substantial attitude change through various forms of communication or persuasion is another indication that affect is fairly independent and often impervious to cognition."

- How effective are production functions for communicating fire-effects in ponderosa forests to the general public? How effective are line drawings for this purpose? The verbal information concerning the effects of light and severe fires on ponderosa forests is identical in three of the four information treatments. Differences between these three treatments reside in the additional information provided by including production-function graphs of fire effects (Treatment 1); line drawings of "before, during and after" conditions for both light and

severe fire (Treatment 2); or both production functions and line drawings (Treatment 3). The fourth information treatment (Control) discussed generalized forest management of ponderosa pine forests without specific reference to fire. Provision of fire-effects information, in general, elicited some differences in both fire knowledge and attitude. Fire knowledge was shifted away from the "control information" assumption of severe fire effects, toward the "expert" position that effects are less severe. This change is notable regarding fire intensity, fire area, impacts of fire on wildlife and the effect of light fire on successional change. There are, however, no discernable differences in fire knowledge relating to the specific form of fire-information presented. Shifts in fire-attitude were away from the "control information" position of intolerance to fire in ponderosa forests toward the "expert" position of greater tolerance. Fire-attitude responses of the production-function and line-drawing information groups are virtually indistinguishable. The full-information treatment (graphs plus line drawings), although not statistically different from the other two fire-information treatments, fairly consistently falls between treatment 1 and 2 levels and the control information levels. This could indicate that the combination of written, graphic plus line-drawing information represents an "information overload," less effective in changing fire tolerance levels than the simpler information sets.

Overall, changes in knowledge and tolerance attitude were not entirely consistent, and are best described as general halo effects. However, Hovland et al. (1953) suggest that a general argument is retained

for a significantly longer period of time than are specifics. Thus, achieving a general halo effect from the fire-information treatments is not negligible.

- What is the relationship between fire-effects knowledge and tolerance of fire in ponderosa pine forests by the general public? Stankey's finding that a significant relationship exists between fire knowledge and tolerance of fire in forest ecosystems was substantiated by the present research. This finding seems intrinsically logical: the more one knows about some phenomenon such as fire, the more tolerant one is likely to be of it, especially if increased knowledge indicates that it isn't as bad as you might have thought.

One final conclusion should be pointed out in relation to U.S. Forest Service fire policy. Just as fire effects may not be as bad as the uninformed public might think, the public's attitude toward the use of prescribed fire may not be as negative as forest managers might think (Biswell, et al., 1973; Nelson, 1979). Of the uninformed public sampled, including control information, no information and the telephone survey sample (Cortner et al.), over 80 percent agreed that forest managers should periodically burn underbrush and debris in pine forests. Over 90 percent of the fire-information treatment respondents agreed with that prescription of controlled burning.

Implications for Future Research

The present research, designed to draw out interrelationships of factors, suggests several future research projects whereby interactions identified could be quantified. Scenic quality evaluations should be

conducted without the complicating factors of information treatments or recreational acceptability evaluations to determine the quantitative responses, over time, of SBE's to severe-fire and light-fire effects. In turn, recreational acceptability evaluations should also be run without concurrent scenic quality evaluations and without application of information treatments. These more simplified experiments would allow more iterations (slide samples) per fire type-recovery condition, thus yielding quantitatively reliable scenic and recreational response functions. Effort should be made to gain RAE's for other recreational activities such as hunting or ORV use to expand the level of knowledge concerning the effects of fire on recreation. The present experimental results suggest the patterns of scenic quality and recreational response one should expect following light and severe fire in southwestern ponderosa pine forests. Single parameter SBE and RAE experiments could produce scenic and recreational (by recreation type) fire-effects production functions commensurate with other Forest Service measurements. Further, these kinds of experiments should be conducted for other forest types. Thus, professional foresters could gain a better understanding of public response to a variety of fire effects conditions in a variety of forest types, and could better respond to legal mandates to manage forests for scenic quality and recreation.

In relation to information treatments, it would be useful to discover whether the general halo effects toward greater tolerance of fire and toward assuming lesser fire impacts might run past expert opinion. Recipients of one information treatment, production functions

plus line drawings, rated erosion effects of severe fire very slightly less severe than did the expert group. Whether more forceful presentations of fire-effects information could effectively distort public fire knowledge and attitudes is a question for serious consideration. Indeed, problems of public acceptance of current fire policies may well stem from overly-forceful selling of fire prevention in the past.

Another area of fruitful future research concerning information treatment would be to investigate the changes in knowledge and attitude achieved through sustained exposure to fire-effects information. The halo effects described resulted from a brief, ten-minute exposure to fire effects information presented in written and graphic form. Would greater fire tolerance and more specific changes in fire-effects knowledge result if such information brochures were provided to forest visitors who had more time to digest the information and to compare it with visible conditions in the forest? Could greater changes in attitude and knowledge be achieved through use of a different presentation media? For example, a series of public seminars or "ranger talks" could be arranged wherein the fire effects verbally described are supported by slides demonstrating the resultant forest conditions.

Of theoretical concern is the question of whether prolonged or more intensive exposure to fire-effects information would effect some change in perception of forest scenic quality or recreational acceptability. Just how "irrevocable" are preferenda (Zajonc, 1980)? Would long term or intensive exposure ultimately affect right-brain

hemisphere processing of feeling -- of affective response. The present experimental materials and results represent a foundation from which this theoretical question could be more deeply explored. The results of such experiments should have profound implications for Forest Service information program policies.

APPENDIX A

INFORMATION TREATMENTS AND TESTING PACKET

Treatment 1

Complete Booklet: Narrative Plus Production Function Information Treatment; Response Sheets; Recreation Choice Sheet; and Post-Test Questionnaire

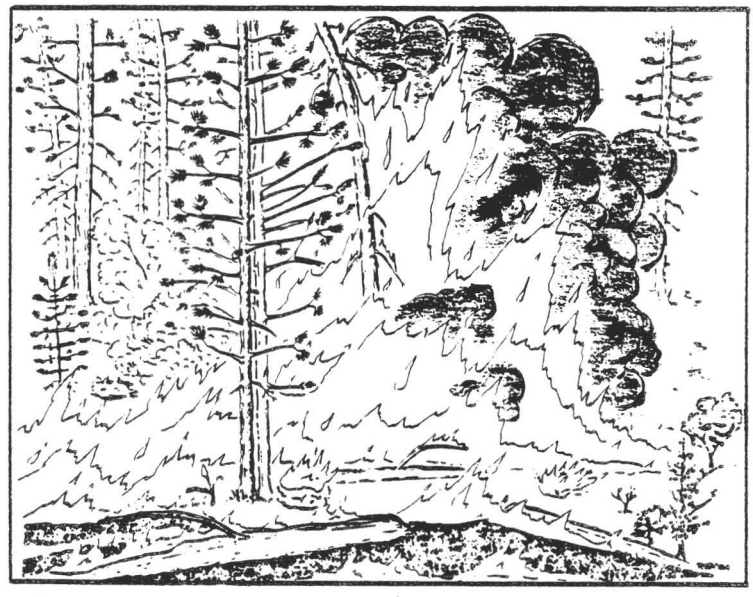
FIRE ECOLOGY OF PONDEROSA PINE FORESTS

National Forests, by law, must be managed for the production of timber, wildlife, water, forage, recreation and aesthetics. One controversial tool for management of these resources is fire.

Fires in forests, and the damage they do, vary greatly depending on the types and amounts of fuel, weather conditions and local topography. A **Light Fire** tends to move slowly through the undergrowth with flames only a few feet high. Surface temperatures are low (around 300°F) and typically only the surface layers of dry litter, fallen branches and logs and a little more than half of the underbrush are burned. Most mature trees are not seriously damaged and the soil keeps a protective cover of organic material.

Ponderosa pine forests in the southwest are adapted to light fires occurring every 5 to 10 years. Mature pines, thick barked and with foliage high above the ground, resist damage from light fires. Occasional flare-ups create openings where direct sunlight and cleared soil allow ponderosa seedlings to germinate and grow. Without fires, other species, such as oak, aspen or juniper will grow and compete with the pines. These competing trees are much less resistant to damage by fire, so light fires provide an important advantage for the ponderosa pine.

At the other extreme, a **Severe Fire** burns much more rapidly with flames reaching and consuming the tops of tall trees. Surface temperatures approximately 1000°F or more consume nearly all the surface organic materials, leaving bare mineral soil and white ash.



If large quantities of fallen logs, branches and needles, and undergrowth are allowed to accumulate in a pine forest, the chances of a severe fire will increase greatly. If shrubs and competing trees grow tall enough, they serve as "fire ladders" carrying the flames into the tops, or "crowns" of the mature ponderosa. These conditions can result in a severe forest fire that burns out of control, tremendously damaging the forest. Frequent light fires can prevent this situation by reducing the amount of litter and brush that might fuel a severe fire.

Based on this understanding of the role of fire in ponderosa, as well as other forest ecosystems, the U. S. Forest Service has developed a fire management policy where severe wildfires are prevented or suppressed, but when conditions are right some light fires may be allowed to burn. In some instances, "prescribed" light fires are intentionally set to help maintain natural ponderosa pine forests, and to prevent the buildup of fuel for a large, destructive wildfire.

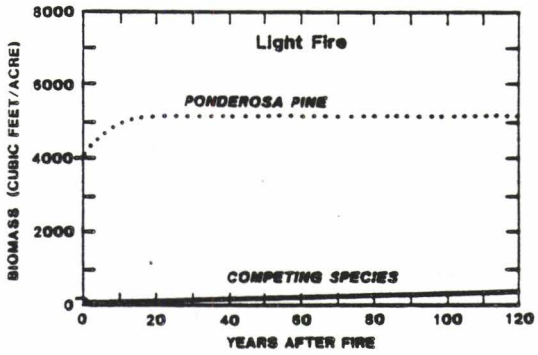
A brief "state-of-the-art" discussion follows of some of the effects that light intensity and **severe** intensity fires can have on different forest resources. These effects are generalized to represent "average" fire effects. The actual effects of any specific fire may differ considerably, depending on weather, soils, slope, and plant and animal species present on the burn site.

Trees

Fire causes extensive damage to tree species that are thin-barked or have much of their foliage within reach of the flames. Fire damage increases among trees that have been weakened by drought stress or insect attack.

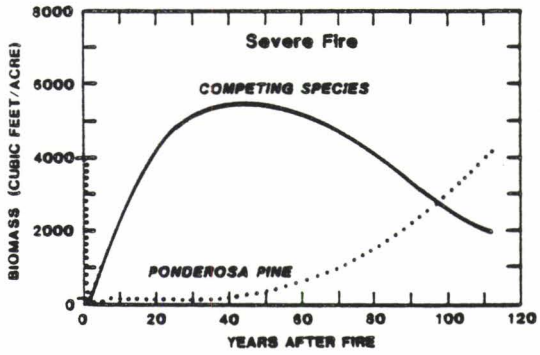
Light fire

- Fire resistant trees, such as mature ponderosa, generally suffer little damage. Mature ponderosa can survive with as much as 80% of their foliage scorched.
- Thickets of immature or stunted ponderosa may be thinned out.
- Competing species (oak or aspen) are killed.
- Undamaged young ponderosa grow more vigorously.



Severe fire

- Most vegetation in the fire's path, including mature ponderosa, is killed or severly damaged, though occasional patches of trees may survive.
- Competing species (oak or aspen) are killed, but recover fairly rapidly, dominating the forest in 30 to 50 years.
- Ponderosa pine recover slowly, gradually replacing the competing tree species in 80 to 100 years.

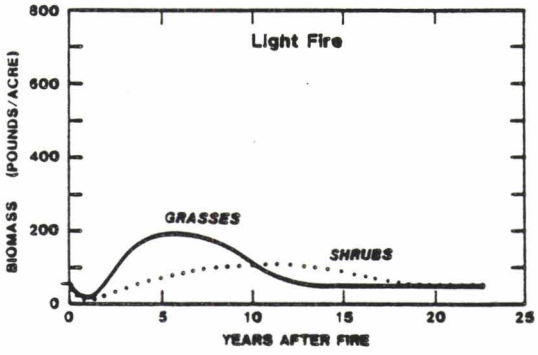


Forage

Grazing animals such as cattle or elk depend on grasses under trees and in forest openings for food. Deer browse primarily on leaves and new growth of shrubs or immature trees. As shrubs and small trees in the forest grow larger, they crowd out grasses needed by cattle and elk and tend to produce less succulent new growth within reach of the deer.

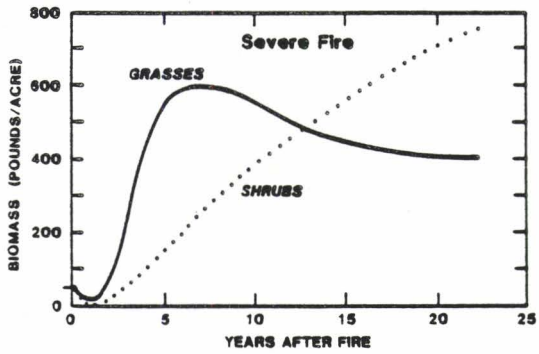
Light fire

- Most shrubs and grasses are burned back to ground level.
- In general, grass production increases for 5 to 10 years.
- Depending on the species present, shrub browse moderately increases for 10 to 15 years.



Severe fire

- The majority of trees, shrubs and grasses are removed.
- With good growing conditions (soils, slope, moisture) grasses recover well within 2 to 3 years. Under poor growing conditions, longer recovery times are required.
- Shrub growth tends to progressively crowd out grasses within 30 years following the fire.
- The shrub community is gradually replaced by trees in 50 to 100 years.



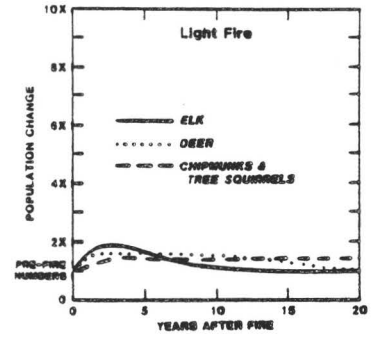
EFFECTS OF FIRE ON WILDLIFE

Mammals

Research indicates that fire damage to most mammal populations is surprisingly low. Direct fire kill is related to the size, intensity and duration of the fire, but in nearly all cases is quite low. In general terms, deer, elk, mountain lion, coyote, black bear and beaver populations improve following fire. Grizzly bear, tree squirrel, chipmunk and marten populations decrease.

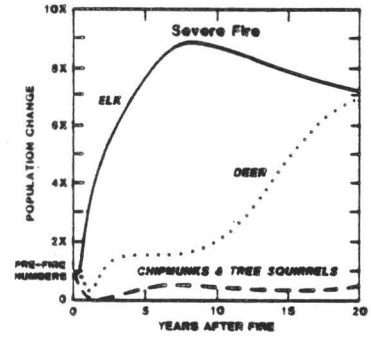
Light fire

- Forest areas are opened up and growth of grasses and shrubs is stimulated. These increased food supplies attract large herbivores such as deer and elk.
- Populations of ground squirrels, tree squirrels, and deer mice are increased.
- Rabbit populations do not increase, apparently due to loss of protective cover.



Severe fire

- After a recovery period, a great increase in forage may occur, greatly increased number of herbivores are attracted to these areas of increased forage.
- Populations of ground squirrels and deer mice increase significantly.
- Tree-dependent species such as tree squirrels and chipmunks are greatly reduced in number.

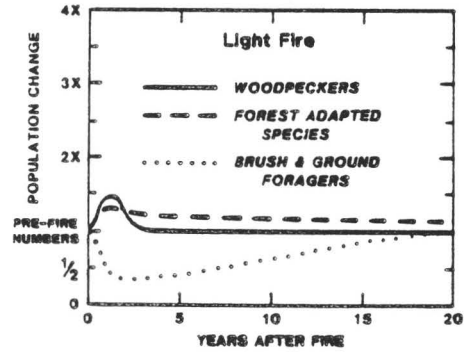


Birds

Direct fire kill of birds is also quite low. The effects of fire on bird populations depends greatly upon the feeding and nesting habits of the bird species, and on the timing and intensity of the fire. Fires that occur during nesting seasons, generally early spring, can be expected to have the greatest impact on bird populations.

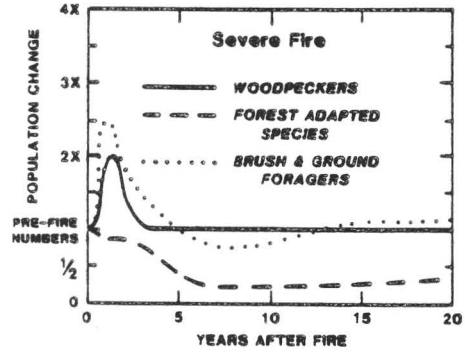
Light fire

- Minor changes in the number and kinds of birds are found.
- Pine forest adapted species such as nuthatches, chickadees and warblers increase.
- Brush and ground foraging birds such as bluebirds, towhees and turkey decrease.
- Woodpeckers benefit for a period of 2 to 3 years.



Severe fire

- Numbers and kinds of birds change greatly due to changes in the forest structure.
- Forest adapted species decline for over 20 years, as do martins and swallows.
- Brush and ground foraging species -- robins, towhees, bluebirds, turkey — benefit.
- Woodpecker populations increase for 2 to 3 years.

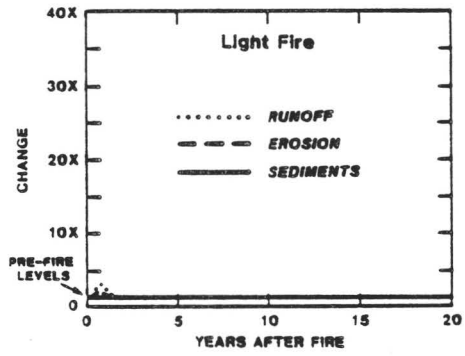


EFFECTS OF FIRE ON WATERSHEDS

The amount and quality of water flowing from a forest watershed is directly related to vegetative cover. Forest vegetation catches a significant portion of rain or snow as it falls, some of which is later evaporated back into the atmosphere. Vegetation and litter cover reduce soil erosion. Exposed soils allow greater water runoff, which in turn increases erosion. Eroded soil particles become suspended sediments in nearby water bodies.

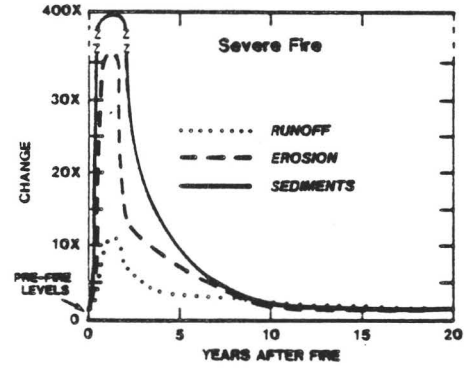
Light fire

- With little change in vegetative structure, changes in water runoff, erosion and sediments are minimal.
- Runoff rates return to normal after one winter season.
- Slight increases in erosion are found only on steep slopes lacking protective humus layers.



Severe fire

- With removal of vegetative and litter cover, runoff rates increase up to 8 times prefire levels but generally return to normal within 20 years.
- Erosion rates may increase up to 35 times prefire levels, but return to normal in about 10 years.
- Suspended sediments, up to 400 times normal concentrations, reduce water quality and can impact fish populations. Sedimentation returns to normal in about 10 years.



EFFECTS OF FIRE ON AIR QUALITY

Where there is forest fire there is smoke. The extent to which this smoke contributes to air pollution depends upon its physical and chemical properties, and upon local weather conditions at the time of the fire. Impacts on air quality generally last from a few hours to several days, and are best understood in terms of smoke components.

Carbon monoxide, a colorless, odorless, toxic gas is produced in substantial quantity, but is rapidly diluted and changed to carbon dioxide. Concentrations 100 feet from forest fire flames are generally lower than levels allowed for 8-hour periods by air quality standards.

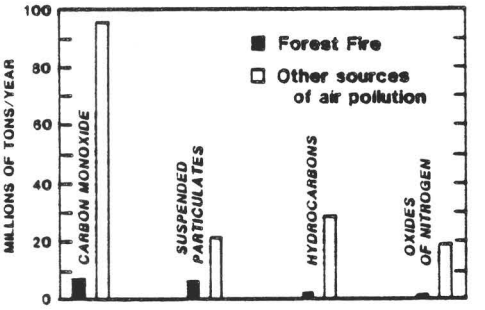
Suspended Particles (smoke) — approximately one-half tar and one-half soot and ash. These particles contribute to cloud formation, become deposited in lungs and on other surfaces, and reduce visibility through the atmosphere.

Hydrocarbons -- The majority of forest fire produced hydrocarbons do not chemically react in sunlight, thus forest fire smoke tends **not** to contribute to photochemical smog.

Oxides of Nitrogen -- These contributors to photochemical smog are produced only in very low amounts, and only by severe fires.

SO_2 — This primary producer of "acid rain" is generally **not** produced by forest fires.

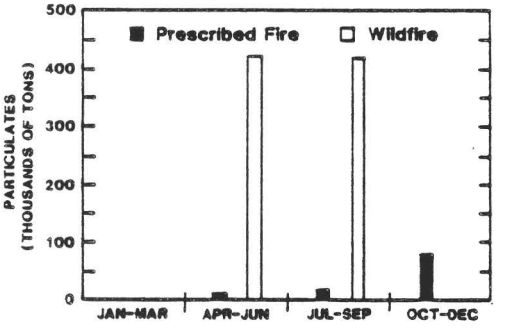
FOREST FIRE'S CONTRIBUTION TO POLLUTION IN U.S.



Light fire

Intentional, or "prescribed" light fires in southwestern ponderosa forests are used to recreate natural forest conditions. The effects of such light fires on air quality should be about the same as from natural light fires which have been occurring in these forest for thousands of years.

FOREST FIRE PARTICULATE PRODUCTION BY SEASON, ROCKY MTN. REGION



Severe fire

Air pollutants from burning live, green plant materials are generally significantly higher than from dead, dry fuels. Smoke emissions from **severe** fires have been estimated to be three times the levels from light fires. Oxides of Nitrogen are emitted into the atmosphere by severe fire but not by light fire.

ENVIRONMENT PERCEPTION RESEARCH

UNIVERSITY OF ARIZONA

TODAY'S DATE — YEAR: 0 1 2 3 4 5 6 7 8 9

MONTH: JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

TEST FORM: 1

RESPONSE SHEET INSTRUCTIONS:

USE PENCIL ONLY, ERASE COMPLETELY WHEN NECESSARY. MAKE YOUR MARKS FIRM AND CLEAR.

EXAMPLE: 1 2 3 4 5 6 7 8 9 10

IDENTIFICATION NUMBER

1 2 3 4 5 6 7 8 9

SCORE 1

1 2 3

SCORE 2

1 2 3

RATING SCALE

LOW 1 2 3 4 5 6 7 8 9 10 HIGH

1	1 2 3 4 5 6 7 8 9 10	21	41	61
2	1 2 3 4 5 6 7 8 9 10	22	42	62
3	1 2 3 4 5 6 7 8 9 10	23	43	63
4	1 2 3 4 5 6 7 8 9 10	24	44	64
5	1 2 3 4 5 6 7 8 9 10	25	45	65
6	1 2 3 4 5 6 7 8 9 10	26	46	66
7	1 2 3 4 5 6 7 8 9 10	27	47	67
8	1 2 3 4 5 6 7 8 9 10	28	48	68
9	1 2 3 4 5 6 7 8 9 10	29	49	69
10	1 2 3 4 5 6 7 8 9 10	30	50	70
11	1 2 3 4 5 6 7 8 9 10	31	51	71
12	1 2 3 4 5 6 7 8 9 10	32	52	72
13	1 2 3 4 5 6 7 8 9 10	33	53	73
14	1 2 3 4 5 6 7 8 9 10	34	54	74
15	1 2 3 4 5 6 7 8 9 10	35	55	75
16	1 2 3 4 5 6 7 8 9 10	36	56	76
17	1 2 3 4 5 6 7 8 9 10	37	57	77
18	1 2 3 4 5 6 7 8 9 10	38	58	78
19	1 2 3 4 5 6 7 8 9 10	39	59	79
20	1 2 3 4 5 6 7 8 9 10	40	60	80

Please indicate what kind of recreation you would enjoy most in forest areas like the ones you have been viewing.

____ 1. driving for pleasure

____ 2. picnicking and day-use

____ 3. nature study

____ 4. hiking or back-packing

____ 5. camping

____ 6. hunting

____ 7. off-road vehicle use

____ 8. other (please specify)

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SCORE 1 1 2 3

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1	1 2 3 4 5 6 7 8 9 10	21	1 2 3 4 5 6 7 8 9 10	41	1 2 3 4 5 6 7 8 9 10	61	1 2 3 4 5 6 7 8 9 10
2	1 2 3 4 5 6 7 8 9 10	22	1 2 3 4 5 6 7 8 9 10	42	1 2 3 4 5 6 7 8 9 10	62	1 2 3 4 5 6 7 8 9 10
3	1 2 3 4 5 6 7 8 9 10	23	1 2 3 4 5 6 7 8 9 10	43	1 2 3 4 5 6 7 8 9 10	63	1 2 3 4 5 6 7 8 9 10
4	1 2 3 4 5 6 7 8 9 10	24	1 2 3 4 5 6 7 8 9 10	44	1 2 3 4 5 6 7 8 9 10	64	1 2 3 4 5 6 7 8 9 10
5	1 2 3 4 5 6 7 8 9 10	25	1 2 3 4 5 6 7 8 9 10	45	1 2 3 4 5 6 7 8 9 10	65	1 2 3 4 5 6 7 8 9 10
6	1 2 3 4 5 6 7 8 9 10	26	1 2 3 4 5 6 7 8 9 10	46	1 2 3 4 5 6 7 8 9 10	66	1 2 3 4 5 6 7 8 9 10
7	1 2 3 4 5 6 7 8 9 10	27	1 2 3 4 5 6 7 8 9 10	47	1 2 3 4 5 6 7 8 9 10	67	1 2 3 4 5 6 7 8 9 10
8	1 2 3 4 5 6 7 8 9 10	28	1 2 3 4 5 6 7 8 9 10	48	1 2 3 4 5 6 7 8 9 10	68	1 2 3 4 5 6 7 8 9 10
9	1 2 3 4 5 6 7 8 9 10	29	1 2 3 4 5 6 7 8 9 10	49	1 2 3 4 5 6 7 8 9 10	69	1 2 3 4 5 6 7 8 9 10
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17	1 2 3 4 5 6 7 8 9 10	37	1 2 3 4 5 6 7 8 9 10	57	1 2 3 4 5 6 7 8 9 10	77	1 2 3 4 5 6 7 8 9 10
18	1 2 3 4 5 6 7 8 9 10	38	1 2 3 4 5 6 7 8 9 10	58	1 2 3 4 5 6 7 8 9 10	78	1 2 3 4 5 6 7 8 9 10
19	1 2 3 4 5 6 7 8 9 10	39	1 2 3 4 5 6 7 8 9 10	59	1 2 3 4 5 6 7 8 9 10	79	1 2 3 4 5 6 7 8 9 10
20	1 2 3 4 5 6 7 8 9 10	40	1 2 3 4 5 6 7 8 9 10	60	1 2 3 4 5 6 7 8 9 10	80	1 2 3 4 5 6 7 8 9 10

QUESTIONNAIRE

We would like to ask you a few questions about forest fires in ponderosa pine forests. These are the tall pine forests such as found on Mt. Lemmon and in the White Mountains.

1. What do you think starts most forest fires in pine forests?

____ a) Human Carelessness

____ b) Arson

____ c) Lightning

____ d) Don't know

2. Compared to other sources of air pollution such as cars, factories and unpaved road, how much of a factor do you think forest fire smoke is in air pollution?

____ a) a MAJOR Factor

____ b) a MODERATE Factor

____ c) a MINOR Factor

____ d) NOT AT ALL a Factor

3. How intense do you think most ponderosa pine forest fires are?

____ a) VERY HOT with high flames

____ b) MODERATELY HOT with medium-size flames

____ c) NOT VERY HOT with low flames

4. How much area do you think most forest fires burn?

____ a) THOUSANDS of acres

____ b) HUNDREDS of acres

____ c) between 1 and 100 acres

____ d) less than 1 acre

5. How do you think a fire that was burning only underbrush and debris would effect a ponderosa pine forest? Do you think it would help keep the area a pine forest, or do you think it would make room and allow other trees to replace pines?

____ a) KEEP IT PINE

____ b) LET OTHER TREES REPLACE PINES

____ c) Don't know

For the next 4 questions, we want you to think in terms of a **rapidly moving, intense forest fire.**

6. How many animals do you think these kinds of forest fires kill?

____ a) a LOT of animals

____ b) a MODERATE NUMBER of animals

____ c) FEW animals

____ d) NO animals

7. Compared to other sources of water pollution such as sewage plants, industrial wastes and urban runoff, how much of a factor do you think these kinds of forest fires are in water pollution?

____ a) a MAJOR factor

____ b) a MODERATE factor

____ c) a MINOR factor

____ d) NOT AT ALL a factor

8. How much soil erosion do you think results from rapidly moving, intense forest fires?

____ a) SEVERE erosion

____ b) MODERATE erosion

____ c) MINOR erosion

____ d) NO erosion at all

9. After these kinds of forest fires, how long do you think it usually is before the grasses and other vegetation begin to grow back?

____ a) within 1 year

____ b) 1 to 3 years

____ c) 3 to 5 years

____ d) NEVER

For the following five statements, please indicate whether you STRONGLY AGREE, AGREE, DISAGREE, or STRONGLY DISAGREE with each statement. The statements concern fires that already are burning in pine forests, regardless of how they got started.

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE
10. Fires that are already burning should be allowed to burn as long as they're watched.	____SA	____A	____D	____SD
11. Fires that are burning underbrush and debris, but not the tall trees, should be allowd to burn as long as they're watched.	____SA	____A	____D	____SD
12. Fires that were started by lightning should be allowed to burn as long as they're watched.	____SA	____A	____D	____SD
13. Fires that were started by human carelessness should be allowed to burn as long as they're watched.	____SA	____A	____D	____SD
14. No fires should be allowed to burn in pine forests.	____SA	____A	____D	____SD

15. Do you agree or disagree with the following statement: Severe fires are less likely to occur in pine forests that have had occasional underbrush fires.

____ a) AGREE

____ b) DISAGREE

16. Do you think forest managers SHOULD or SHOULD NOT periodically burn underbrush and debris in pine forests?

____ a) SHOULD

____ b) SHOULD NOT

Concerning the information brochure (the orange covered booklet) which you read first:

17. Please rate the brochure on a one to ten scale where one means incomprehensible and ten means completely clear.

Brochure rating: _____

18. If you had received this brochure, unsolicited, in your mail, do you think you would have read it?

____ a) YES ____ b) NO

Finally: Have you been telephone interviewed within the past month about fire in pine forests?

____ a) YES ____ b) NO

Treatment 2

Narrative Plus Line Drawings

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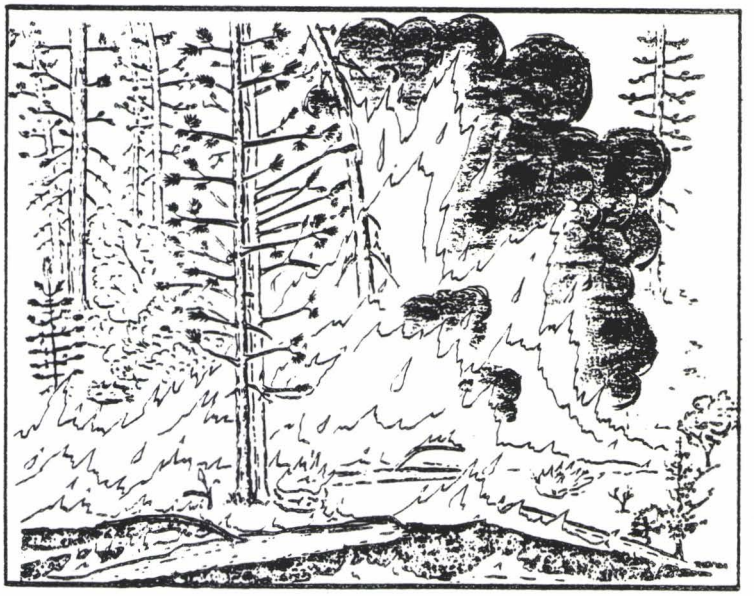

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- Ponderosa pine recover slowly, gradually replacing the competing tree species in 80 to 100 years.

Forage

Grazing animals such as cattle or elk depend on grasses under trees and in forest openings for food. Deer browse primarily on leaves and new growth of shrubs or immature trees. As shrubs and small trees in the forest grow larger, they crowd out grasses needed by cattle and elk and tend to produce less succulent new growth within reach of the deer.

Light fire

- Most shrubs and grasses are burned back to ground level.
- In general, grass production increases for 5 to 10 years.
- Depending on the species present, shrub browse moderately increases for 10 to 15 years.

Severe fire

- The majority of trees, shrubs and grasses are removed.
- With good growing conditions (soils, slope, moisture) grasses recover well within 2 to 3 years. Under poor growing conditions, longer recovery times are required.
- Shrub growth tends to progressively crowd out grasses within 30 years following the fire.
- The shrub community is gradually replaced by trees in 50 to 100 years.

Mammals

Research indicates that fire damage to most mammal populations is surprisingly low. Direct fire kill is related to the size, intensity and duration of the fire, but in nearly all cases is quite low. In general terms, deer, elk, mountain lion, coyote, black bear and beaver populations improve following fire. Grizzly bear, tree squirrel, chipmunk and marten populations decrease.

Light fire

- Forest areas are opened up and growth of grasses and shrubs is stimulated. These increased food supplies attract large herbivores such as deer and elk.
- Populations of ground squirrels, tree squirrels, and deer mice are increased.
- Rabbit populations do not increase, apparently due to loss of protective cover.

Severe fire

- After a recovery period, a great increase in forage may occur, greatly increased number of herbivores are attracted to these areas of increased forage.
- Populations of ground squirrels and deer mice increase significantly.
- Tree-dependent species such as tree squirrels and chipmunks are greatly reduced in number.

Birds

Direct fire kill of birds is also quite low. The effects of fire on bird populations depends greatly upon the feeding and nesting habits of the bird species, and on the timing and intensity of the fire. Fires that occur during nesting seasons, generally early spring, can be expected to have the greatest impact on bird populations.

Light fire

- Minor changes in the number and kinds of birds are found.
- Pine forest adapted species such as nuthatches, chickadees and warblers increase.
- Brush and ground foraging birds such as bluebirds, towhees and turkey decrease.
- Woodpeckers benefit for a period of 2 to 3 years.

Severe fire

- Numbers and kinds of birds change greatly due to changes in the forest structure.
- Forest adapted species decline for over 20 years, as do martins and swallows.
- Brush and ground foraging species -- robins, towhees, bluebirds, turkey -- benefit.
- Woodpecker populations increase for 2 to 3 years.

The amount and quality of water flowing from a forest watershed is directly related to vegetative cover. Forest vegetation catches a significant portion of rain or snow as it falls, some of which is later evaporated back into the atmosphere. Vegetation and litter cover reduce soil erosion. Exposed soils allow greater water runoff, which in turn increases erosion. Eroded soil particles become suspended sediments in nearby water bodies.

Light fire

- With little change in vegetative structure, changes in water runoff, erosion and sediments are minimal.
- Runoff rates return to normal after one winter season.
- Slight increases in erosion are found only on steep slopes lacking protective humus layers.

Severe fire

- With removal of vegetative and litter cover, runoff rates increase up to 8 times prefire levels but generally return to normal within 20 years.
- Erosion rates may increase up to 35 times prefire levels, but return to normal in about 10 years.
- Suspended sediments, up to 400 times normal concentrations, reduce water quality and can impact fish populations. Sedimentation returns to normal in about 10 years.

EFFECTS OF FIRE ON AIR QUALITY

Where there is forest fire there is smoke. The extent to which this smoke contributes to air pollution depends upon its physical and chemical properties, and upon local weather conditions at the time of the fire. Impacts on air quality generally last from a few hours to several days, and are best understood in terms of smoke components.

Carbon monoxide, a colorless, odorless, toxic gas is produced in substantial quantity, but is rapidly diluted and changed to carbon dioxide. Concentrations 100 feet from forest fire flames are generally lower than levels allowed for 8-hour periods by air quality standards.

Suspended Particles (smoke) — approximately one-half tar and one-half soot and ash. These particles contribute to cloud formation, become deposited in lungs and on other surfaces, and reduce visibility through the atmosphere.

Hydrocarbons -- The majority of forest fire produced hydrocarbons do not chemically react in sunlight, thus forest fire smoke tends **not** to contribute to photochemical smog.

Oxides of Nitrogen -- These contributors to photochemical smog are produced only in very low amounts, and only by severe fires.

SO_2 — This primary producer of "acid rain" is generally **not** produced by forest fires.

Light fire

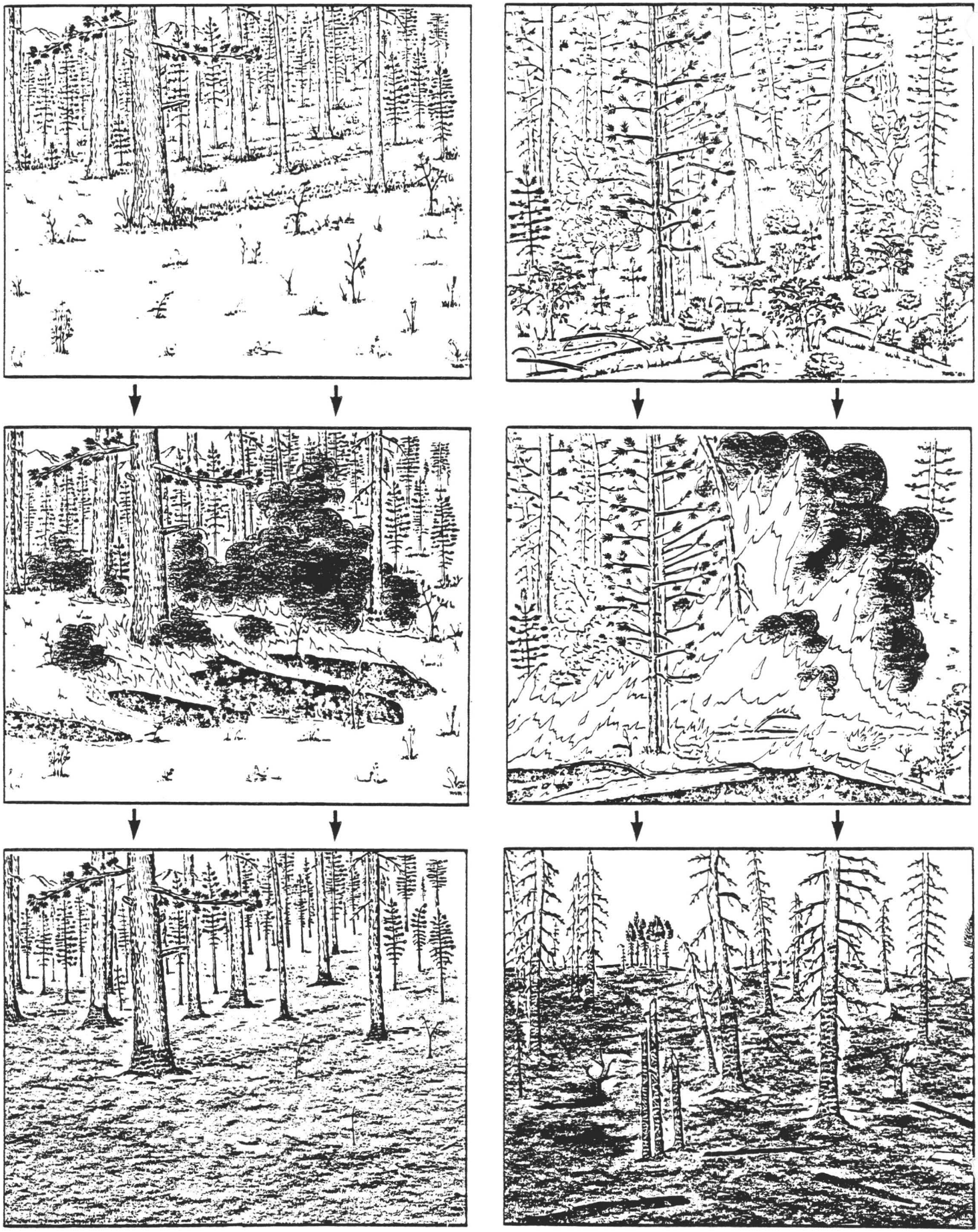
Intentional, or "prescribed" light fires in southwestern ponderosa forests are used to recreate natural forest conditions. The effects of such light fires on air quality should be about the same as from natural light fires which have been occurring in these forest for thousands of years.

Severe fire

Air pollutants from burning live, green plant materials are generally significantly higher than from dead, dry fuels. Smoke emissions from severe fires have been estimated to be three times the levels from light fires. Oxides of Nitrogen are emitted into the atmosphere by severe fire but not by light fire.

LIGHT FIRE

SEVERE FIRE



Treatment 3

Full Information Treatment: Narrative
Plus Production Functions
Plus Line Drawings

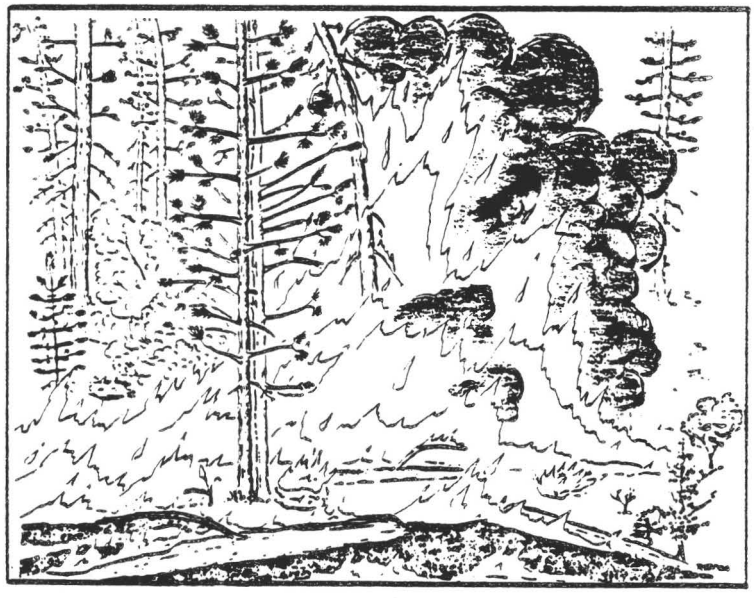
National Forests, by law, must be managed for the production of timber, wildlife, water, forage, recreation and aesthetics. One controversial tool for management of these resources is fire.

Fires in forests, and the damage they do, vary greatly depending on the types and amounts of fuel, weather conditions and local topography. A **Light Fire** tends to move slowly through the undergrowth with flames only a few feet high. Surface temperatures are low (around 300°F) and typically only the surface layers of dry litter, fallen branches and logs and a little more than half of the underbrush are burned. Most mature trees are not seriously damaged and the soil keeps a protective cover of organic material.

Ponderosa pine forests in the southwest are adapted to light fires occurring every 5 to 10 years. Mature pines, thick barked and with foliage high above the ground, resist damage from light fires. Occasional flare-ups create openings where direct sunlight and cleared soil allow ponderosa seedlings to germinate and grow. Without fires, other species, such as oak, aspen or juniper will grow and compete with the pines. These competing trees are much less resistant to damage by fire, so light fires provide an important advantage for the ponderosa pine.

At the other extreme, a **Severe Fire** burns much more rapidly with flames reaching and consuming the tops of tall trees. Surface temperatures approximately 1000°F or more consume nearly all the surface organic materials, leaving bare mineral soil and white ash.

If large quantities of fallen logs, branches and needles, and undergrowth are allowed to accumulate in a pine forest, the chances of a severe fire will increase greatly. If shrubs and competing trees grow tall enough, they serve as "fire ladders" carrying the flames into the tops, or "crowns" of the mature ponderosa. These conditions can result in a severe forest fire that burns out of control, tremendously damaging the forest. Frequent light fires can prevent this situation by reducing the amount of litter and brush that might fuel a severe fire.



Based on this understanding of the role of fire in ponderosa, as well as other forest ecosystems, the U. S. Forest Service has developed a fire management policy where severe wildfires are prevented or suppressed, but when conditions are right some light fires may be allowed to burn. In some instances, "prescribed" light fires are intentionally set to help maintain natural ponderosa pine forests, and to prevent the buildup of fuel for a large, destructive wildfire.

A brief "state-of-the-art" discussion follows of some of the effects that light intensity and **severe** intensity fires can have on different forest resources. These effects are generalized to represent "average" fire effects. The actual effects of any specific fire may differ considerably, depending on weather, soils, slope, and plant and animal species present on the burn site.

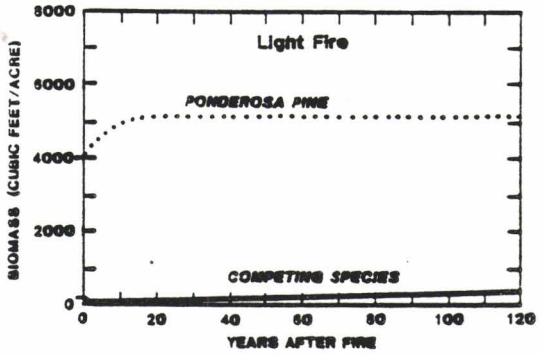
EFFECTS OF FIRE ON VEGETATION

Trees

Fire causes extensive damage to tree species that are thin-barked or have much of their foliage within reach of the flames. Fire damage increases among trees that have been weakened by drought stress or insect attack.

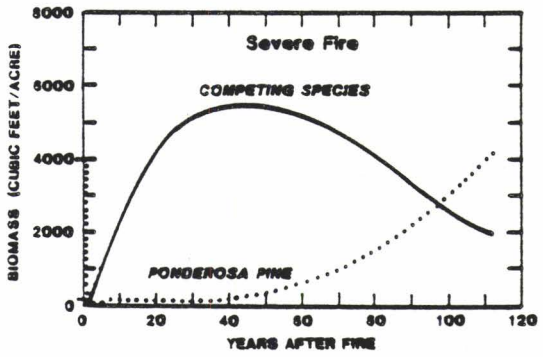
Light fire

- Fire resistant trees, such as mature ponderosa, generally suffer little damage. Mature ponderosa can survive with as much as 80% of their foliage scorched.
- Thickets of immature or stunted ponderosa may be thinned out.
- Competing species (oak or aspen) are killed.
- Undamaged young ponderosa grow more vigorously.



Severe fire

- Most vegetation in the fire's path, including mature ponderosa, is killed or severly damaged, though occasional patches of trees may survive.
- Competing species (oak or aspen) are killed, but recover fairly rapidly, dominating the forest in 30 to 50 years.
- Ponderosa pine recover slowly, gradually replacing the competing tree species in 80 to 100 years.



Forage

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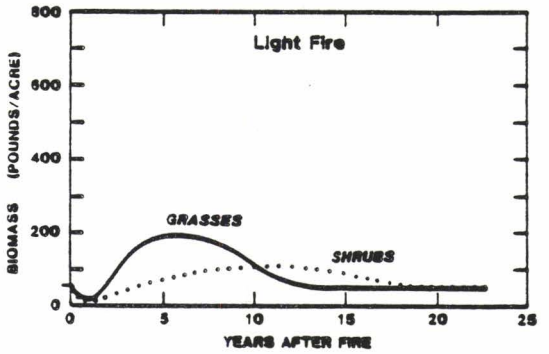

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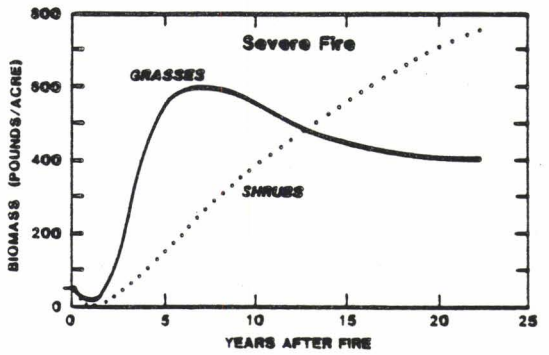

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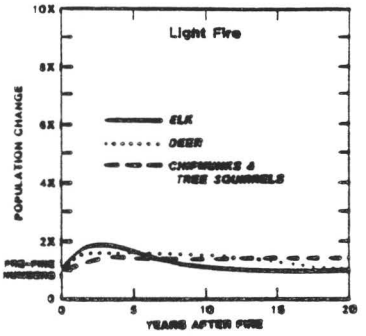

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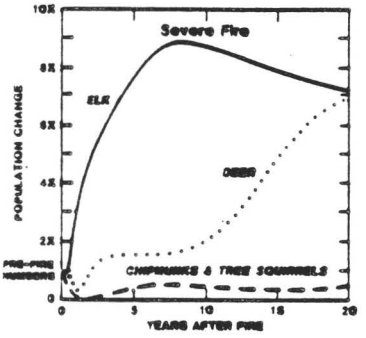

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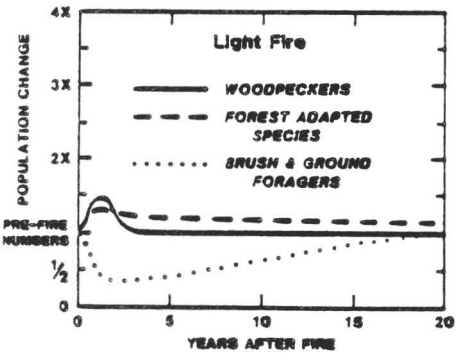

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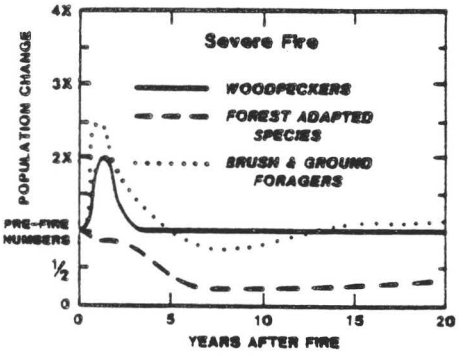

EFFECTS OF FIRE ON WATERSHEDS

The amount and quality of water flowing from a forest watershed is directly related to vegetative cover. Forest vegetation catches a significant portion of rain or snow as it falls, some of which is later evaporated back into the atmosphere. Vegetation and litter cover reduce soil erosion. Exposed soils allow greater water runoff, which in turn increases erosion. Eroded soil particles become suspended sediments in nearby water bodies.

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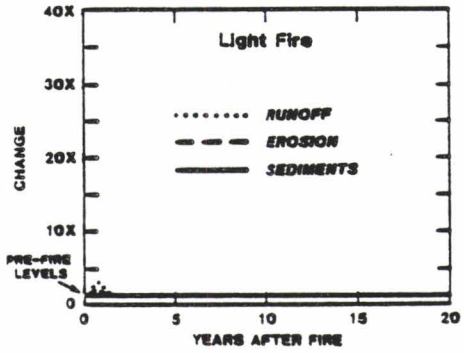

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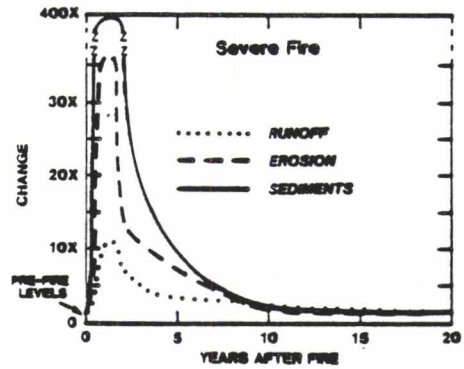

EFFECTS OF FIRE ON AIR QUALITY

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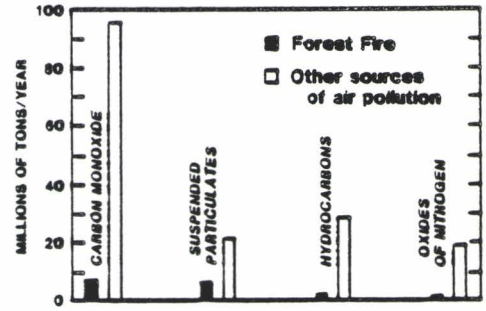
Oxides of Nitrogen -- These contributors to photochemical smog are produced only in very low amounts, and only by severe fires.

SO_2 — This primary producer of "acid rain" is generally not produced by forest fires.

FOREST FIRE'S CONTRIBUTION TO POLLUTION IN U.S.



Light fire

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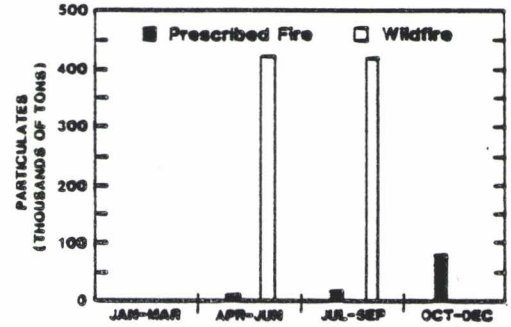
FOREST FIRE PARTICULATE PRODUCTION BY SEASON, ROCKY MTN. REGION

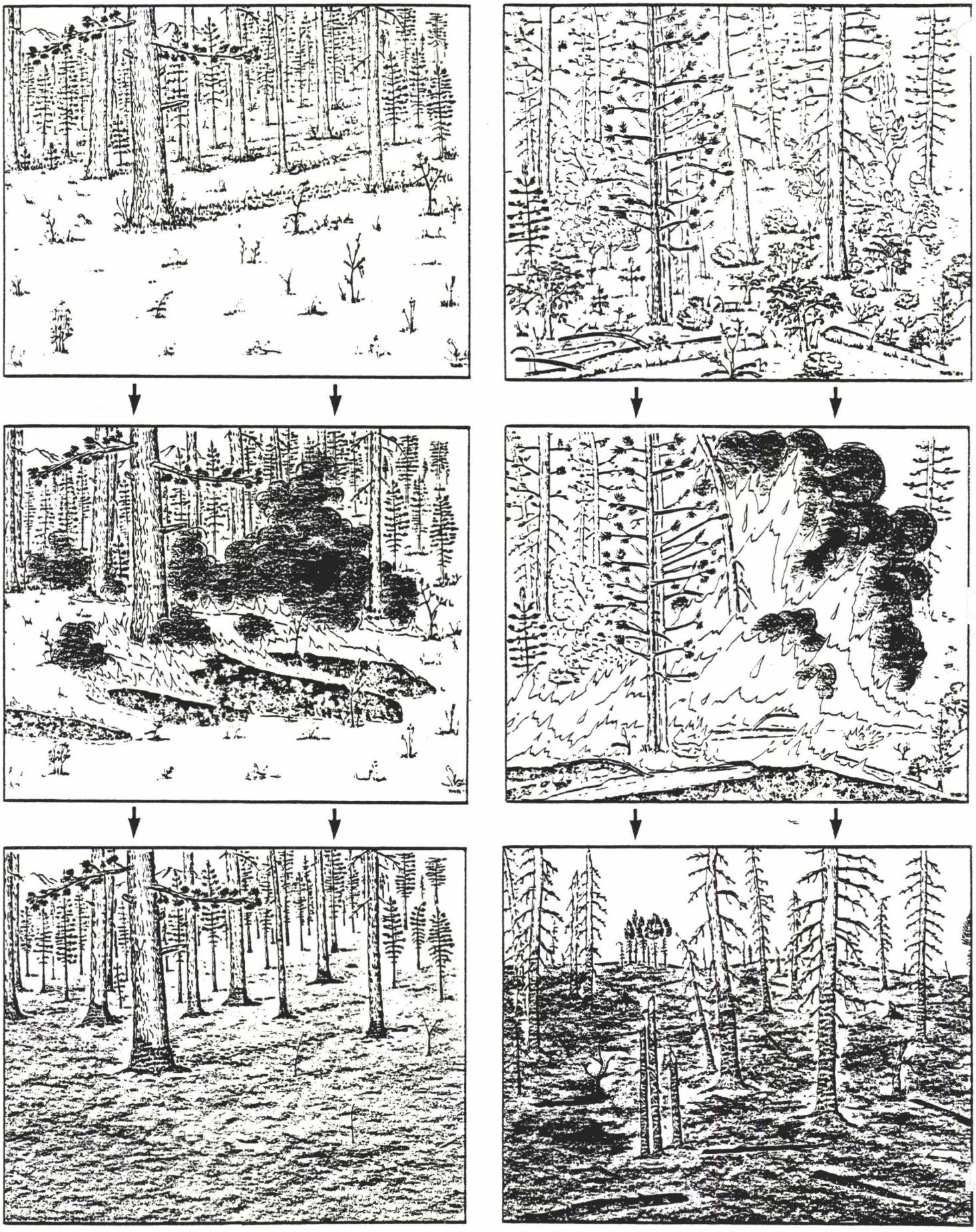


Severe fire

Air pollutants from burning live, green plant materials are generally significantly higher than from dead, dry fuels. Smoke emissions from severe fires have been estimated to be three times the levels from light fires. Oxides of Nitrogen are emitted into the atmosphere by severe fire but not by light fire.

LIGHT FIRE

SEVERE FIRE



Treatment 0

Control Information:
Generalized Forest Management

FOREST ECOLOGY OF PONDEROSA PINE

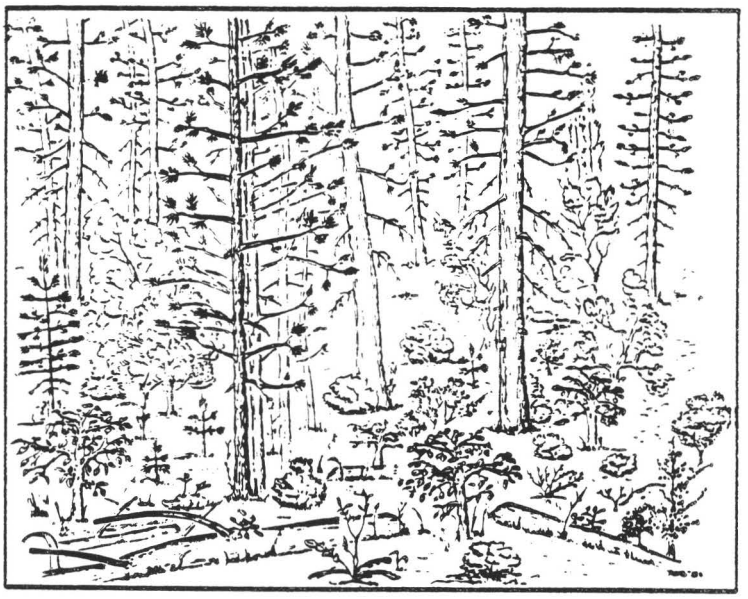
National Forests, by law, must be managed for the production of timber, wildlife, water, forage, recreation and aesthetics. There are a number of management methods available to the professional forester for protecting and improving these multiple resources.

Forests are one of the nation's most significant **renewable** natural resources. That is, through the application of good management practices it is possible to use the various resources of the forest, but still always have them available. A variety of timber harvesting techniques can be applied, depending upon the amount of lumber needed and the growth characteristics of the tree species. Seedlings of shade tolerant species can grow in the shade of taller trees. Other species, including ponderosa pine, require openings with bare soil and direct sunlight for seedlings to germinate and grow. Thus, harvesting and clearing patches or strips is necessary to assure regrowth of ponderosa pine.

These timber harvesting objectives, however, must be balanced with production of other resources. For example, clearing large areas down to bare mineral soil for the production of ponderosa seedlings could bring about increased soil erosion and reduced water quality in nearby streams and lakes.

The production of forage for wildlife and livestock can compete with production of timber. Fortunately, in ponderosa pine forests, there is often a healthy undergrowth of grasses and small shrubs, thus competition between forage and timber production generally is minimal.

Forestry practices must sometimes be modified in areas of high recreation use. Logging practices that leave scars on the land or quantities of unattractive slash are severly restricted in scenic and/or recreation areas.



One tool available to the forester in management of these forest resources is fire. Some foresters feel that judicious use of fire can be very helpful in managing the ponderosa pine forest. Other foresters feel that all fires are harmful to some extent, or that fire is too dangerous to attempt to use as a forest management tool.

A brief discussion follows of some of the considerations that must be born in mind in attempting to manage multiple resources in a ponderosa pine ecosystem.

VEGETATION MANAGEMENT

Tree Growth

Ponderosa Pine

Ponderosa require cleared soil and direct sunlight for seedlings to germinate and grow. Often, selected trees are left standing in clearings to provide the seed source for future seedlings. These new young stands can grow up overcrowded, however, and unless thinned may produce dense thickets of stunted trees. Some thickets of ponderosa in the southwest have 50 year old trees less than two inches in diameter.

Competing Species

Other tree species of lower timber value tend to compete with ponderosa pine in the southwest. Aspen competes at higher elevations, oak and juniper at lower elevations. These competing trees are shade tolerant, and thus can grow up under the ponderosa canopy. Some techniques that have been used to control these competing species include selective cutting, use of fire and application of herbicidies.

Forage Production

Grazing animals such as cattle and elk depend on grasses under trees and in forest openings for food. Deer browse primarily on leaves and new growth of shrubs or immature trees. As shrubs and small trees in the forest grow larger, they tend to crowd out the grasses needed by cattle and elk. These larger shrubs and trees also produce less succulent new growth within reach of the deer. Again, some means of controlling shrub and competing tree growth is required.

Conversely, grazing must be controlled in areas with young ponderosa seedlings, otherwise the wildlife and livestock can kill the young trees, preventing regeneration of the area in ponderosa pine.

WILDLIFE MANAGEMENT

Mammals

The excellent forage provided by undergrowth in ponderosa forests or in small clearings attract large herbivores such as deer and elk. Populations of ground squirrels, deer mice, chipmunks and tree squirrels are often abundant in ponderosa ecosystems. The Abert's squirrel is particularly well adapted to ponderosa, relying primarily on this tree species for both food supply and nesting sites. If populations of tree squirrels become too large, however, and begin excessive feeding on the tender growing tips of the ponderosa, damage to the timber value of the stand can occur.

Birds

A number of pine-forest adapted species thrive in southwestern ponderosa ecosystems. Species such as nuthatches, chickadees and warblers are especially well adapted to ponderosa. In the small clearings and brushy areas found dispersed through ponderosa forests, brush and ground foraging species such as robins, bluebirds, towhees and turkeys thrive. Woodpeckers and flickers are found, especially associated with standing snags, or dead trees.

WATERSHED MANAGEMENT

The amount and quality of water flowing from a watershed is directly related to the vegetative cover. Forest vegetation will catch a significant portion of rain or snow as it falls. Some of this precipitation will later be evaporated back into the atmosphere. Forest vegetation and litter reduce erosion of raindrops on the soil surface, and the accumulation of forest litter helps water to seep into the soil to recharge groundwater supplies. Exposed soils allow greater water runoff, which in turn increases erosion. Eroded soil particles become suspended sediments in nearby water bodies.

Thus forest vegetative cover tends to decrease the total amount of watershed runoff water, but maintains high water quality.

BALANCE

The forester tries to maintain a balanced system which can provide continuing use of all of these forest resources. Sometimes, however, his or her decisions must involve tradeoffs between different resources: for example, timber production at the expense of optimum watershed conditions; recreational use at the expense of maximum wildlife habitat. These tradeoff decisions can become especially difficult when conflicting pressures are brought to bear on the forester by opposing groups of people: the lumber industry vs. the community dependent on the water supply; campers and backpackers vs. hunters. Thus the foresters' decisions must be made in a social as well as an ecological context.

APPENDIX B

STANDARDIZED INSTRUCTIONS

APPENDIX B

STANDARDIZED INSTRUCTIONS:

(Scenic Evaluation First)

Seat all subjects where they will have a good view of the screen.

Hold questions about the study until after the session has been completed.

Hand out respondent packets and pencils.

"I will read standardized instructions so that everyone participating in these studies will start with the same information. I have to ask you please to hold all questions and discussion until after we have completed the excercise, at which time I will be pleased to answer all your questions to the best of my ability.

Congress has passed a number of laws to protect environmental quality. Forest management laws require protection of the scenic beauty and recreational qualitites of forest areas, in addition to production of timber and other resources. The present research has two purposes: first, to test the effectiveness of some different public information documents; and secondly to determine the public's perception of both scenic beauty and recreation potential of certain forest areas. We greatly appreciate your help in this effort. You each have in your packets a short brochure (the orange colored one) presenting some information about Ponderosa Pine forests. Since we are trying to test different ways of presenting the information, the booklets are different.

The longest takes about 10 minutes to read. We would like you to read through the information on the orange pages at this time. Please save your comments until we have completed today's session."

(When all have finished reading, proceed.)

"For the next part of the study, I am going to show you some color slides taken in Ponderosa Pine forest areas in the southwest showing a variety of fire histories. We would like you to look at each scene separately, and to judge the scenic beauty represented at the time the color slide was taken. The next item in your packet should be a rating sheet. (Hold up a rating sheet.) Use the rating scale shown at the top of this sheet to indicate your judgement for each scene. Notice that the scale extends from ONE, indicating that you judge the scenic beauty to be very low, to TEN, indicating very high scenic quality. Before you begin to rate scenes, I will quickly show you a few slides to give you an idea of the kind of scenes you will be evaluating. Try to imagine how you would rate these scenes on the scale, but do not write anything down at this time. O.K., here are the preview slides:

(Show preview slides at 5 seconds each.)

I'm sure you are all probably familiar with these "mark-sense answer sheets" but in case someone isn't: Use the pencil to fill in the little box under the rating number you select. Please be careful not to make any random marks on the page.

Now, please rate each of the following scenes using the ONE to TEN scenic quality scale. Slides will be presented rather briefly, but you will have time to judge each scene and mark your rating. I will announce

which slide number we are on so you can keep your place on the rating sheet. Please try to use the full range of the rating scale, and be sure to indicate a number for each scene shown. Do you have any questions about what to do? Here is the first scene: Please enter your rating for scene number one -- upper left on your score sheet -- from 1 - very low scenic quality to 10 - very high scenic quality."

(Show slides at 8 seconds per slide. Announce every slide number. IF someone gets confused, early on, go back and start at the beginning again.)

"That was the last slide in this set. Now, please turn to the next rating sheet.

For this part of the study we are going to ask you to rate similar forest areas for recreational acceptability. First, on the white page facing your rating sheet there is a list of different kinds of outdoor recreation. Please indicate the one kind of recreation you would enjoy most in these kinds of forest environments -- forest areas such as you have just been viewing. If your preferred recreation is not listed, please write it in the space next to 'other'."

(Pause until recreation type is indicated.)

"This time, please use the rating scale to indicate how good each area shown would be for the kind of recreation you checked on the list. Here, ONE would indicate that you judge the area to be very unacceptable for your preferred recreation. TEN would indicate that you judge the area to be excellent for that kind of recreation. Do you have any questions about the rating procedure?

Now, please rate each of the following scenes using the ONE to TEN recreation acceptability scale. I will announce slide numbers again. Please try to use the full range of the rating scale, and be sure to indicate a number for each scene shown. Refer each time to your preferred recreation. Here is the first scene, enter your first rating: from 1 = unacceptable to 10 = excellent for your recreation."

(Show slides at 8 seconds per slide. Announce numbers.)

"That was the last scene. Now, for the last part of this exercise, we have a short questionnaire we would like you to fill out. It is the last item in your packet, please fill out both sides."

(When all have finished, proceed.)

"Thank you very much for your help. Please turn in your whole packet as soon as you're done.

Now, I will be happy to answer any questions you may have about this study to the best of my ability."

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